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Hybrids and Intergrades[1]

By Emmett Reid Dunn

THIS paper is an endeavor to discuss the various populations and individuals which are intermediate between two groups currently recognized as species or subspecies. These are sometimes considered hybrids and sometimes intergrades. I shall consider these from various points of view in order to determine if there is any possible method of distinguishing the two, and suggest the proper taxonomic procedure.

1. Point of View of Genetics. An attempt to define the populations recognized in herpetological terminology by genetic criteria follows:

(a) Species. Individuals of a species are *similar* because they have similar genetic compositions. Individuals of other species are *different* because they have different genetic compositions. Individuals of a species are *distinct* from those of other species because there are *no* individuals which are genetically intermediate between those of the species in question and those of any other species *and which inherit these intermediate genetic combinations* from a period in which the differences in genetic makeup were not so marked as at present.

(b) Subspecies (races). The definition for subspecies is quite the same, for the first two sentences, as that for species. The last sentence should be altered to read: Individuals of a subspecies are *not distinct* from those of another race of the same species because there *are* individuals which are genetically intermediate between those of the two subspecies in question *and which inherit these intermediate genetic combinations* from a period in which the differences in genetic makeup were not so marked as at present.

(c) Hybrids. Hybrid individuals are intermediate between those of the two parent species because of intermediate genetic composition, but this is *not inherited from a period antedating* the formation of the two parent species.

(d) Intergrades. Genetically similar to hybrids between species, but are intermediate anatomically and genetically between subspecies, and their genetic composition is *inheritcd from a period antedating the formation* of the two subspecies between which they are intermediate.

(e) Should the integrades of section "d" become extinct the two subspecies between which they are intermediate would ipso facto cease to conform to the definition of subspecies, and would conform to the definition of species, and be so considered by herpetologists. This is the "origin of species" as understood by Darwin, clarified but not changed by modern knowledge.

Attention to the foregoing will at once disclose that certain essential features of these definitions are entirely outside the scope of genetics *qua*

[1] Contributions from the Department of Biology, Haverford College, No. 27.

genetics. Therefore it is impossible to define the subspecies and species of herpetological practice in purely genetic terms, and no refinement of genetic knowledge will ever alter this. If subspecies and species cannot be distinguished on genetic grounds alone it is manifestly impossible to distinguish hybrids from intergrades on these grounds.

Since Darwin first made it clear that no essential difference exists between the categories of variety, subspecies, and species (but that one category changes into the next by gradual accumulation of new and different hereditary characters and by the elimination of older ones with the extermination of their bearers) it has been equally clear that no conceivable increase in knowledge of genetics could serve to distinguish them one from another. None the less, numerous workers, even up to the present, seem to have concepts of some mystical transformation which converts a variety or a subspecies into a species, and to imagine that this unspecified, imaginary difference can be tested by genetic methods.

There are ordinarily more genetic differences between two species of the same genus than between two races of the same species, but this is not necessarily true. There are many cases of distinct species which differ by few hereditary characters, and also many cases of two races of the same species which differ by many. Distinctness (absence of intergrades), not degree of difference, is the criterion whereby the category species is distinguished from the category subspecies in herpetological practice.

It may be suggested that taxonomists are not competent to define the categories with which they deal and that they should take these definitions from some other source (preferably from geneticists?). C. Tate Regan's famous dictum, "a species is what is called a species by a competent taxonomist," comes to mind here, and I should never dream of insulting an experimental biologist by calling him a competent taxonomist. It is inevitable that the categories of species and subspecies should be developed and defined by taxonomists, whose business it is to deal with them. They alone have the requisite first-hand knowledge of the populations concerned.

The method of inheritance of characters is no criterion of taxonomic status. This should be obvious enough since every known type can be found in the various strains of the same species. Presence or absence of dominance in crosses involving characters dependent on single Mendelian factors, presence or absence of characters involving multiple factors—none of these can ever be expected to serve as tests between specific and subspecific crosses since all of them are known to occur in varietal crosses.

Lipsett and Piatt (COPEIA, 1, 1936: 1) say: "It is supposed that true species owe their divergence to single factor allelomorphs and obey the simple law of Mendelian Dominance, while subspecies differences are of a multiple factor nature and consequently show a phenotypic blending." I know nobody else who entertains any such supposition; one which can immediately be refuted by reference to the genetic behavior exhibited by crosses between strains of a single taxonomic form. Genetic investigation of intermediates while it may advance genetic knowledge, can only be termed futile if it is intended to establish their taxonomic status.

2. Quality of Characters and of Combinations.

If two animals are not too different in anatomy, physiology, and psychology they may mate and produce offspring, even though they may be of different genera. The consequent offspring may or may not be fertile inter se, and if fertile the customary segregation and free assortment may be expected to go on in a mathematically predictable fashion, so that in any generation half of the hybrid population should, in the totality of their characters, be as like the one ancestor as the other.

If, however, the two ancestral types are quite distinct, it might be expected that various disharmonic and relatively inefficient combinations might appear as the result of crossing. Also, the more different genetically the two ancestral types, the more variable should be the resultant population, after free assortment and segregation of genes.

Thus in true hybrid populations great variability and disharmonic combinations of characters should appear.

The converse should be expected in intergrades, as two races between which cross breeding has persisted should not produce an intermediate population of such great variability or one in which marked disharmony of combinations is noticeable.

I think that these principles give us a rule of thumb by which populations of hybrids can often be distinguished from populations of intergrades. Two contrasting cases are: the intermediates between Mongols and Malays in southeast Asia, which I should consider intergrades; the intermediates between Malays and Melanesians in the eastern Lesser Sundas, which I should consider hybrids in the sense that the two ancestral types had enjoyed a long period of isolation from each other and had met and secondarily begun to mingle strains. The variability and the number of disharmonic combinations in the latter population are truly remarkable and far exceed that resulting from Caucasian-Negroid crossing in the West Indies.

This rule of thumb may be summarized:

a. Intermediates of relatively uniform nature; relatively few in number; sterile inter se ?; F1 generation ?.....probably or certainly hybrids
b. Intermediates very variable; often with marked disharmony of character combinations; F2-n generation ? .....probably hybrids
c. Intermediates variable for some few minor characters; no marked disharmony... .....probably intergrades

3. Evidence from Ecology, Geography, etc.

In all cases of doubt every line of supporting evidence should be utilized. The problem is one of phylogeny, an attempt to portray the history of animals up to the present, and this cannot be done without reference to their present and past surroundings.

4. Procedure.

There will always be a certain number of cases whose true status is impossible to determine, which may equally well be considered intergrades or hybrids. It is usually better to consider these as intergrades, since in all probability renewal of breeding relationships after separation and complete differentiation is a rarer phenomenon among animals than incomplete or partial differentiation.

The Code apparently adheres to a pre-Darwinian concept of hybrids as occasional, sterile offspring of specifically distinct parents. It directs that they shall not be given taxonomic recognition. This precept may well be kept under the wider view and extended to include populations composed of hybrids. In my opinion the same procedure should be applied to intergrades; that is, they should not be given scientific names.

Of course a population of hybrids or of intergrades need not be, at the present time, in actual breeding contact with either of the two parental populations (cf. the Pitcairn Island hybrids).

Theoretically the status of a hybrid population would alter if one of the parental groups should become extinct. It would then have certain characters of its very own (those of the extinct parent group) and should receive taxonomic recognition. I doubt if this is likely to become practically important.

Cases are known of hybrids which, as a result of certain genetic combinations (probably of recessive genes), show characters possessed by neither of the two parental types. Here again theory might suggest that they be awarded taxonomic recognition. In practice they are not given it when the parentage is known, but if any have been encountered as populations in nature, and of unknown ancestry, they almost certainly have received, and are likely to receive, taxonomic recognition.

In any discussion of hybrids and integrades I would suggest that it is proper to consider offspring of two subspecies of the same species as hybrids if the two subspecies are not normally connected by intergrades. This situation is likely to occur where a species has many subspecies, some of which may be more dissimilar than many distinct species, and only connected with each other by a series of vicarious forms.

Taxonomic procedure will not be embarrassed by the occurrence of intergrades or hybrids if it names neither of them. It is, and always will, be embarrassed when intermediates have been discovered and named before one or both of the two populations which they connect. When this has occurred, the least awkward procedure possible is indicated. If all three have been named, the intergrade earlier than either of the main populations, it is perhaps best to recognize three groups (as in the case of *Microtus pennsylvanicus* on the Atlantic coast). If one main population and an intergrade has been named, and the other main population is yet unnamed, it is best not to name it, but to extend the definition of the intergrade name to cover the other main population. The best practice, in my opinion, is to avoid undue multiplication of named populations.

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Two New Lizards of the Genus *Leiolopisma* from Mexico, with Comments on Another Mexican Species

By Edward H. Taylor

AMONG the collections made by Dr. Hobart Smith and myself in Mexico, I find two forms of *Leiolopisma* which I believe to be new. One of these, *Leiolopisma silvicolum,* is a lowland, arboreal species, the other, *Leiolopisma forbesorum,* is a terrestrial, plateau form.

These diminutive skinks are difficult objects of study, since in many forms the typical equipment of head scales is almost generic in its fixity, and the same typical pattern may be presented again and again in forms occurring even on different continents. It becomes necessary to look for specific characters in the scales of the nuchal and temporal regions as well as on the anterior part of the head, and to scrutinize carefully body squamation and proportions to find characters to define two forms which the eye can discern as different from their *tout ensemble.* Then too it is necessary to consider the age of the specimen since the relative body proportions change with age. This is especially true of the length of limb in proportion to axilla to groin measurement, the limbs being proportionally longer in the young than in the old. Most species having the adpressed legs separated in the adult may have them touching or overlapping in the young.

Leiolopisma ***silvicolum,*** sp. nov.

Type.—No. 10033 ♀, E.H.T. Collection; type locality, forested hill about 10 miles southeast of Cordova, near San Lorenzo, Vera Cruz; August 19, 1936; elevation a little under 2,000 ft. Edward H. Taylor, collector.

Paratype.—No. 10034 ♂, same locality, date and collector.

Diagnosis.—A member of the "Oligosoma" group, having two frontoparietals. Interparietal enclosed by parietals. Scales in 30–32 rows around middle of body, 38–40 about axillary region; lateral scales smaller than dorsals which in turn are smaller than ventrals; 20 lamellae under longest toe; normally two pairs of nuchals, anterior not in contact with the upper secondary temporal; limbs pentadactyl, elongate; when adpressed they overlap somewhat more than length of longest toe; posterior loreal higher than long. Ear opening large, round, smaller than eye opening; tympanum deeply sunk; frontal shorter than frontoparietals and interparietals together. Above brown, with a light dorsolateral line interrupted by dark brown dots. A rather distinct, lateral, dark brown stripe, punctated with small, rounded, dull cream spots; uniform cream-white below, without pigment or metallic reflections, save a few dark spots on latter half of tail.

Description of the Type.—Larger than *forbesorum,* with body more robust. Rostral large, its broad transverse suture with frontonasal not extending as far back as a line drawn between anterior edge of nostrils; suture between the rostral and first labial, when extended, bisects the nostril; part of rostral visible above slightly less than length of frontoparietal; frontoparietal (2.2 x 1.5 mm.), one and one-half times as wide as long, touching anterior loreal laterally; prefrontals rounded posteriorly, narrowly in contact with first

supraocular, touching both loreals and first superciliary and separated from each other by a distance little more than half the length of rostro-frontonasal suture; frontal elongate (3.2 x 2 mm.), its length a third greater than its distance from end of snout; two interparietals, touching three supraoculars; interparietal very slightly longer than wide, enclosed by parietals; diagonal length of the latter scales equal to distance between posterior edge of interparietal and frontal; two pairs of nuchals, both relatively narrow, anterior pair separated from upper secondary temporal by a single scale.

Nostril pierced in middle of a diagonally-elongate nasal; two loreals, the anterior the higher and narrower; posterior loreal distinctly higher than long; a small preocular bordered by three scales posteriorly; three presuboculars, separated from a series of four postocular scales by two small granular scales; four supraoculars; nine scales in superciliary series, last two and first largest, last of the series wedged between last supraocular and parietal, but not completely separating them; seven upper labials, sixth much the largest, fifth the subocular; primary temporal much larger than lower secondary; upper secondary still much larger, bordered behind by three scales, the two lower are equal-sized, tertiary temporals; lower secondary temporal fan-shaped; seventh labial separated from auricular opening by three pairs of scales diminishing in size posteriorly; six lower labials, fifth longest; mental with a longer labial border than rostral; one large postmental, much larger than mental; three large, paired chinshields, posterior pair rounded posteriorly, separated by three scales, first pair in contact; pair of scales bordering third chinshield (postgenials) narrow, elongate, the inner the longest. A small, transparent disk on lower eyelid, separated from the subocular by about four rows of minute scales, the lower rows largest; upper palpebral scales (except first two) in contact with superciliaries; auricular opening round, its diameter a little more than half length of eye opening.

Limbs well developed, longest fingers reaching posterior corner of eye; two outer posterior tubercles on wrist enlarged; lamellar formula for fingers, 6:10:12:14:10; two rows of scales on dorsal surface of fingers, save the two distal scales, which are single; terminal scales of digits bound tightly about claw; lamellar formula for toes, 7:12:16:20:14; dorsal surface of toes with two scale series, save the two distal scales, which are single, and the proximal part, which has three series; tubercles under sole numerous (about 35), variable in size; series bordering heel enlarged, the median posterior not or but slightly larger than adjoining scales; lamellae under toes slightly compressed, but not keeled; eight scales border anus; the median, preanal scales much enlarged, overlapping adjoining scales, which in turn overlap outer. Scales about body in straight, parallel rows, save in axillary region, where they have an upward, diagonal trend; scales of post-auricular region, about arm insertion, in axillary region, in groin and on side of the base of tail, together with scales on posterior side of upper arm and posterior side of femur with usually three, short, minute keels; scales about neck close behind ear, 38; about narrow part of neck, 33; 2 mm. behind arm insertion, 39; about middle of body, 30–32 (the latter number very slightly in advance of the middle).

The median scale row under the tail is differentiated by being larger than

and of different shape from adjoining scales. In the median row the scales are alternately larger and smaller, and the scales of the adjoining series which alternate with a large and small scale are of three sizes, small, medium and large (whether this continues to end of tail is not known, since in both type and paratype the distal part of tail is missing).

Color: Above, dark olive-brown to bronzy brown, with numerous minute darker flecks, not showing any tendency to form lines; a very indistinct, narrow, dorsolateral, light line on middle of fourth scale row, interrupted irregularly by dark spots. Below light line is a broad, dark brown or blackish stripe, with numerous lighter dots, covering two whole rows and two half-scale rows; the five scale rows below the stripe are pigmented with ashy-gray; a few scattered dark brown spots on the side; a light area in superciliary region and greater part of eyelid pigmentless; lips light with darker areas on sutures; limbs light tan above, with numerous irregular blackish flecks; undersurface of hands and feet dark; a very indistinct light line from eye through the ear to arm, crossing about middle of ear; under surface of body and limbs creamy white; tail lighter brown than body.

Measurements of type ♀ *and paratype* ♂ *respectively in millimeters:* Snout to vent, 58.2, 54; snout to eye, 4.1, 3.9; snout to ear, 10.3, 10.1; snout to arm insertion, 18.6, 19.8; axilla to groin, 32.5, 28.3; head width, 7.5, 7.5; head length to posterior edge of parietals, 9.8, 10; arm, 13, 13.6; leg, 21, 21.8; longest toe, 7, 7.2.

VARIATION.—The paratype agrees in all essential characters, save that the frontal is a trifle longer, the left posterior nuchal is broken and the scale separating the first nuchals from the upper secondary temporal is larger.

REMARKS.—The species is related to *Leiolopisma gemmingeri,* a species briefly described by Cope (Proc. Acad. Nat. Sci. Phila., 1864: 180) from Orizaba, Vera Cruz, Mexico, and to *Leiolopisma unicolor* (Harlan), widely distributed in the United States. The differences are shown in the key at the end of the paper.

The type was first observed about ten feet from the ground on the bole of a large forest tree. It was brushed from this position with a rod, and immediately took refuge in a hole at the base of the tree. After a short time it reappeared, minus a tail, and was captured.

The paratype was observed running on the bole of a smaller tree about twenty feet from the ground. It took refuge in a small epiphytic plant about thirty feet from the ground, where I captured it. No others were seen. The elongate limbs and toes appear to be adaptations to an arboreal habitat.

Leiolopisma gemmingeri (Cope)

Oligosoma gemmingeri Cope, Acad. Nat. Sci. Phila., 1864: 180 (type locality, Orizaba, Vera Cruz, Mexico; type no. 6331, U.S.N.M.); Proc. Acad. Nat. Sci. Phila., 1865: 187 (mention only); Bull. U. S. Nat. Mus., no. 32, 1887: 45 (Orizaba, Rio Verde, Jalapa, Zacualtipan).

Lygosoma (Mocoa) gemmingerii Bocourt, Mission Scientifique au Mexique, Reptilia, Livr. 7, 1881: 449–450 (Tehuantepec, Mexico).

?*Mocoa lateralis (part.)* Günther, Biologia Centrali-Americana, Reptilia and Batrachia, August, 1885: 31 (Jalapa).

?*Lygosoma laterale (part.)* Boulenger, Cat. Liz. Brit. Mus., 2nd Ed., 1887: 263 (Jalapa, Vera Cruz, Mexico).

The status of *Oligosoma gemmingeri* Cope has been in doubt since Boulenger placed the species in the synonymy of *Lygosoma laterale* (Say) [=*Leiolopisma unicolor* (Harlan)]. I recently examined the cotypes in the United States National Museum, and believe that Cope's name must be revived for a species occurring in Vera Cruz (and Tehuantepec, if Bocourt's specimens are correctly associated with Cope's species). There is no question that the species is distinct from *Leiolopisma unicolor* (Harlan).

The cotypes, four in number, two males and two females, are catalogued in the National Museum under the single number 6331 with Orizaba as the type locality. In the type description one infers a single specimen, since more than one is not mentioned.

Data is here recorded (measurements in millimeters) respectively on the four cotype specimens distinguished by snout to vent measurement as follows: ♂51, ♂54, ♀60, ♀64; head width, 6.4, 6.6, 6.7, 7.3; head length, 7, 7.5, 8.2, 8.8; axilla to groin, 31, 32.8, 34, 38.6; eye to tip of snout, 8.6, 9.5, 11.3, 10.3; diameter of tympanum, 1.65, 1.7, —, 1.7; arm 9.5, 10.6, 11.3, 11.5; leg, 15.6, 18.5, 16, 18.5; longest toe, 4.6, 5.5, 5.5, 5.6; scale rows behind ear, 34, 34, 33, 34; neck, 27, 28, 30, 30; about axilla 36, 34, 34, 37; about middle of body, 28, 26, 28, 28; lamellae under fourth toe, 14, 15, 16, 17; nuchals, pairs, 2, 2, 1, 2; scales, parietals to above vent, 62, 65, 67, —; legs when adpressed, separated by scales, 9, 7, 12, 11; prefrontals touch, yes, no, no, no; upper labials, 7, 7, 7, 8–7; lower labials, 6, 6, 6, 6; presuboculars, 3, 3, 3, 3; postsuboculars, 4, 4, 4, 4.

The scale following the upper secondary temporal may be interpreted as an upper tertiary temporal. The scales suggest a pair of nuchals that fail to meet medially. The primary temporal is large, in three specimens much more than half the size of upper secondary temporal, and equal to or larger than lower secondary temporal; the frontoparietals touch three supraoculars. The chinshields are typical, second pair separated by a single scale, third by three scales; one large postmental.

The nuchals are narrow transversely, apparently equivalent to two ordinary scales; the median anal scales are very large, the median scales overlapping outer. The subcaudal scales are very slightly enlarged, scarcely wider than adjoining scales. The pre- and post-subocular series are continuous, but the fourth from front is reduced in size.

The bodies are yellow to amber or golden brown, with an amber dorsolateral line more or less distinct; dorsal surface usually with small scattered dark brown blotches or spots on the back. The ventral surface is iridescent; certain specimens show blackish marks on sides of chin. A dark brown lateral band along side of head and body to tail.

Leiolopisma ***forbesorum***, sp. nov.

TYPE.—No. 10043, La Placita, Hidalgo (8 miles south of Jacala), July 2, 1936; elevation about 7,000 ft. E. H. Taylor, collector.

PARATYPES.—Nos. 10035—10042, 10044—10045; same locality and collector, July 2–3, 1936.

DIAGNOSIS.—Related to *Leiolopisma silvicolum* and *L. gemmingeri*, but differing from the former in having shorter, more poorly developed limbs, which fail to meet in both males and females (adults) when adpressed, in the character of the tertiary temporals and nuchals, and number of scale rows; from *gemmingeri* it differs in the character of the temporals and nuchals, in having a shorter body (shorter axilla to groin distance in proportion to total length); it is a smaller species.

Normally a single large nuchal, curving about the parietals and in contact with the very large upper secondary temporal; a lateral brown band to tail, but not distinctly continued on tail; this is bordered above by a very dim, usually continuous narrow light line, while the lower edge is less densely dark, with occasional lighter blotches; the dark stripe involves upper third of ear; lower on sides, color lead gray, with occasional darker flecks, especially on side of head and neck and on lips; subcaudals enlarged; they are wider and longer than adjoining scales, and each is fan-shaped; arm reaches a little beyond ear; scale rows about middle of body, 28; maximum length, 54.2; frontoparietal divided.

DESCRIPTION OF TYPE.—Rostral large, the part of scale visible above includes posterior labial borders; the suture with frontonasal forms a slight groove, caused by the slightly thicker rostral edge; frontonasal much wider than long, broadly in contact with anterior loreal and nasal laterally, with frontal and prefrontals posteriorly; frontal one-fourth to one-third longer than its distance from tip of snout; four supraoculars; their length equals that of scales between nuchal and frontal; frontoparietals divided, right scute larger; interparietal broadly enclosed by parietals; ten scales in superciliary series, the two posterior, below and behind last supraocular, nearly as large as the first. Nasal large, single; first loreal higher than second (abnormally divided transversely in type on both sides, leaving a small postnasal above loreal); second loreal about as high as long; a small preocular followed by one or two scales; three presuboculars, anterior largely in front of eye; five postsuboculars, the two series more or less continuous by means of two or three small scales above the subocular labial; seven labials, fourth and first smallest, fifth and sixth with longest labial borders, sixth and seventh largest and about equally high; primary temporal one-third or one-fourth size of upper secondary temporal, about equal or somewhat smaller than lower secondary temporal; the main axis of this latter scale is directed backward and downward; two small tertiary temporals bordering upper secondary temporal, upper of the two not in contact with parietal; a transparent disk on eyelid; six lower labials; mental border larger than rostral; undivided postmental; three pairs of chinshields, first pair in contact, second pair separated by one scale, third pair by three scales; postgenials behind third chinshield somewhat elongate, equal; vertical diameter of ear a fifth greater than its horizontal diameter; the distance from ear to eye equals distance from eye to tip of snout; distance between arm and ear about equal to distance from ear to nostril; scales smooth, save areas about insertion of limbs which show minute short keels, those on side of neck usually much less distinct. Median anal scales enlarged, the inner scales

overlapping outer; scales around neck behind ear, 34; narrow part of neck, 29; behind arm, 35; about middle of body, 28. Scales in a row from parietal to above anus, 64; scales on sides are perhaps slightly smaller than those on back or belly; scales under tail, fan-shaped, larger than adjoining scales which are variable in size; posterior part of tail regenerated, under which the scales are much widened; limbs short; when adpressed, separated by six scales; lamellar formula for hand, 6, 9, 11, 11, 8; for foot, 7, 10, 13, 16, 11; pads on hand about 25; outer posterior scale on wrist much enlarged; on foot, scales bordering heel rather large, the small pads on feet about 22.

MEASUREMENTS (IN MM.) AND SCALE COUNTS OF *Leiolopisma forbesorum*

Number	10040	10038	10037	10043	10044	10036	10035	10039	10041	10042
Sex	♀	♂	♀	♀	♀	♀	♀	♀	♂	♀
Snout to vent	54.2	52.5	51.5	51	51	50.2	50	49.2	48	46
Snout to eye	3.7	3.6	4.1	3.5	3.8	3.5	3.5	3.7	3.7	3.1
Snout to ear	9.6	9.1	10	9	8.8	8.7	9.2	8.7	9.4	8.5
Snout to foreleg	18.8	17.5	18.2	16.5	16.5	16	16.1	15.3	17.6	15.5
Axilla to groin	30	29.2	26.2	30.2	30	27	28	28	27	26.4
Tail	reg.	reg.	reg.	reg.	broken	reg.	reg.	reg.		69
Head width	7	6.9	7	6.8	6.1	6.8	7	6	6.9	6.1
Head length to nuchal	9.2	8.6	9.1	9	8	8.5	8.3	8	8.6	8
Arm	11	10.8	12.5	10.2	10.5	10	10	10.2	10.2	10
Leg	16.1	16.7	15.6	17	15.2	15	15.2	15	14.6	15
Longest toe	5.8	5.4	6	5.7	5.2	5.2	5.1	5	5.1	5.1
Scales behind ear	34	36	34	34	33	35	34	35	36	36
Scales about neck	29	28	30	29	30	28	28	30	29	30
Scales 2 mm. behind axilla	35	36	35	35	36	35	36	36	35	37
Scales about middle of body	28	28	28	28	28	28	28	28	26	28
Scales in row from parietal to above anus	62	67	62	64	68	67	64	68	60	65
Lamellae under 4th toe	18	16	19	17	16	17	15	18	16	19
Legs separated by scales	8	5	1	6	7	7	6	6	4	3
Scales around ear		24	25	23	23	24	24	24	24	23

Color in life: Above grayish to amber-brown, covering six whole scale rows and two half rows; a blackish lateral stripe on head and side of body, bordered above by an indistinct continuous light line, more or less greenish white in color; the lower edge of the stripe becomes lost in the bluish lead color of sides, which is flecked with black; an indistinct light line from nostril, passing below eye through middle of ear to forearm, yellowish anteriorly, bluish posteriorly; labials and region below ear with numerous dark flecks. Ventral surface generally light, yellowish under tail, and with some metallic reflections on abdomen and throat.

VARIATION.—The general characters are the same in all, save that females have slightly shorter legs, and a slightly greater axilla to groin measurement, hence the separation between adpressed limbs is greater. All the paratypes have the first loreal single (broken in type). The single pair of nuchals is constant in six of the series; two have one of the two broken on one side; one has the nuchals broken on both sides; two have the large pair of nuchals, followed by a pair of narrow nuchals; in one there is also an extra (third) nuchal on the left side. The very large size of upper secondary temporal is

constant. One specimen shows the lower secondary very much smaller than the primary. The table shows variation in measurements and scale counts.

REMARKS.—These specimens were taken in low forest among boulders. Some were discovered moving about in the grass; others were routed from under stones. Several that were seen escaped into crevices.

This species is named for Mr. and Mrs. Dyfrig McH. Forbes, my hosts at Potrero Viejo, Vera Cruz, whose splendid hospitality made my stay with them an exceedingly pleasant one. Their very material help and untiring effort in collecting both during the day and night added greatly to my collection, and gave me cause to marvel at their endurance. I am deeply indebted to Mr. Forbes for a number of rare snakes from his personal collection.

KEY TO AMERICAN *Leiolopisma* OF THE "OLIGOSOMA" GROUP

A. Frontoparietal single; keels present or absent ..... "Mocoa" group
AA. Frontoparietal double; minute keels present on scales on sides, especially in regions near insertion of limbs ..... "Oligosoma" group
  B. Lateral brown or black stripe passing above ear; 3 to 4 pairs of narrow, transversely widened nuchals, the first pair separated from upper secondary temporal by an elongate upper tertiary temporal; upper secondary temporal relatively small; limbs widely separated when adpressed, a distance equal to length of from 10–20 lateral scales (greatest in females); tympanum oval; 72–80 scales in a line from parietal to above anus (central and southern Texas specimens) ..... *Leiolopisma unicolor* (Harlan)
  BB. Lateral brown stripe usually covering two whole scale rows, and halves of adjacent rows, involving upper part of ear.
    C. Limbs of large adult males and females strongly overlapping when adpressed; scale rows about middle of body, 30–32. Dorsolateral light line more or less broken by dark spots; normally two pairs of rather small nuchals, the first pair separated from upper secondary temporal by a small scale; arm reaches eye; scales, parietal to above anus, 66–70 ..... *Leiolopisma silvicolum*, sp. nov.
    CC. Limbs of large adult males and females fail to touch or at most barely touch when adpressed. Scale rows about body 26–28; dorsolateral line usually continuous. Arm reaches ear or slightly beyond.
      D. Body elongate, the axilla to groin distance equals 60.3 per cent of snout to vent length in adult males (average 59.3 per cent in males and females); normally two pairs of nuchals, narrow transversely, separated from upper secondary temporal; known maximum size 64.8 ♀ ..... *Leiolopisma gemmingeri* (Cope)
      DD. Body shorter, the axilla to groin distance about 51 per cent in adult males, 55.8 per cent in males and females; normally one pair of large nuchals curving about parietals and in contact with upper secondary temporals; known maximum size, 54.2 ♀ ..... *Leiolopisma forbesorum*, sp. nov.

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Breeding Habits of *Farancia abacura* in Captivity

By George P. Meade

COMPLETE records of the breeding habits of snakes are comparatively rare. (See Wood; Copeia, 2, 1933.) The following report of the mating of a pair of mud snakes, *Farancia abacura*, with the subsequent egg-laying and hatching of the young seems to be the first case recorded for this species. An attempt to hatch a clutch of eggs of *Farancia* was reported last year by the writer (Copeia, 4, 1935) but this was unsuccessful as the only fertile egg was perforated by insects before reaching maturity.

The female of the mating pair (not the same one that laid the eggs last year), which was captured in the spring of 1935, measured one inch short of six feet and weighed 4 lbs. 10 oz. at the time of the mating. The male, captured early in June of this year, was much smaller, measuring 42 inches and weighing only 1 lb. 10 oz. These snakes, together with several others of the same species, were housed in an outdoor cage about six feet square in which there was a shallow pool covering about one-half of the cage, the remainder of the area being concrete. All the specimens fed readily on the tailed amphibian (*Amphiuma tridactylum*) in the manner previously reported (Copeia, 2, 1934).

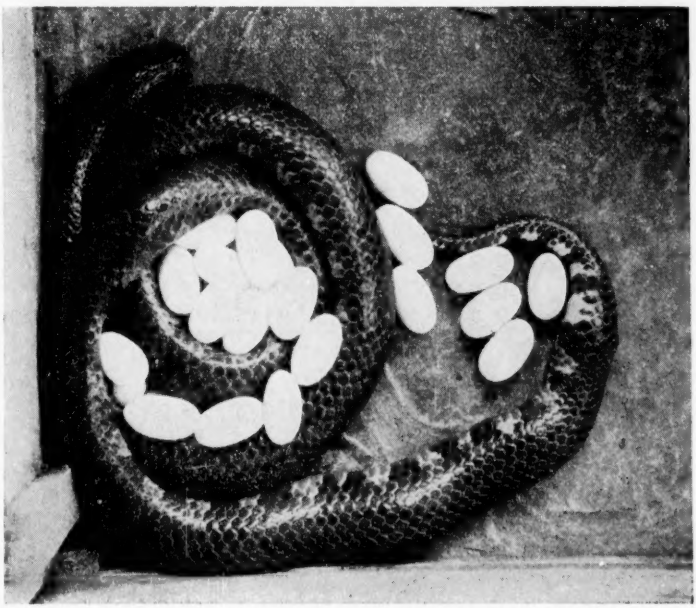
The mating was first observed about 7 A.M. on July 11. The paired snakes were then in the water but they moved onto the concrete soon afterward where they remained coupled throughout the day. During much of this time the female was in a loose coil with the male in a fairly straight line at right angles to the posterior part of her body. The other snakes in the cage showed no interest in the mating. At 10:30 P.M., the snakes, observed with a flashlight, were again in the water still coupled but the following morning they had separated and no further inclination to mate was noted. There were no courtship activities seen on the days previous to the mating although the occupants of the cage were under frequent observation.

The writer was absent on a trip at the time of the egg-laying but preparations had been made to have the data recorded and the eggs taken care of. Thanks are due Mr. Henry G. Gerstner, of Gramercy, for his careful observations as well as for the excellent photographs which he took, one of which accompanies this article. The first egg was laid at about 7 A.M. on September 5, just eight weeks from the date of the mating. The deposition continued intermittently until about 1:30 P.M., when twenty-eight had been laid in all. The eggs were cream-white elongated spheroids, smooth, non-adhesive, regular in size and shape, the diameter varying from 13/16 to 15/16 of an inch and length from 1 5/8 inches to 1 7/8 inches. The shells, which were flexible and leathery, were marked with numerous small brown rod-like flecks in groups of two and three and lying parallel to the elongated axis.

The photograph shows the snake and eggs just after the last laying. It seemed evident to the observers that an attempt was being made by the snake to keep the eggs within the coils of her body as they were laid but whether this was for the purpose of incubating them or merely to hold them in a close group could not be determined. A heavy rain was threatening and as the floor of the cage was concrete it was feared that the force of the

rain might damage the eggs so they were removed.

The medium selected for incubating the clutch was the residue left from grinding sugar cane (bagasse) in the form in which it is sold for use as a mulch for flowers and as "litter" for small chickens. This material has been dried, sifted and sterilized at 1400° F. and it proved admirably suited for the purpose as it is highly absorbent, clean, free from insects or constituents which attract insects. During the eight weeks that this material was kept moist it developed no odor whatever. None of the eggs mildewed in this medium and none was destroyed by insects.



Photograph by H. G. Gerstner

Farancia abacura and Eggs
September 5, 1936
Position immediately after last egg was laid; not posed.

Three days after the laying the snake refused to feed but on the fifth day she attacked and swallowed a large *Amphiuma*. A few days later half of the partly digested amphibian was disgorged. Two other *Amphiuma* were eaten in the three following weeks after which the snake ceased to feed for the winter as has been found customary with this species.

During the month of September the eggs embedded in this moistened bagasse were kept all together in one box but on the writer's return about October 1 it was decided to divide them into two portions, to avoid the possibility of all the eggs being destroyed by some accident. Cool weather was approaching and the problem was to keep the eggs warm without overheating them. Half the eggs were put in a second box containing moist

bagasse which was left undisturbed in a room having both southern and western exposures. The sunlight entering this closed room kept it at summer heat during the day and moderately warm at night. On two occasions toward the end of the incubation period the nights were so cold that steam heat was turned on in the room. The bagasse was sprinkled with fresh water every two or three days.

In transferring the eggs one shell was accidentally perforated and was opened showing a well developed yolk containing an embryo embedded in it. This left thirteen eggs in this box and fourteen in the first one. The original box was kept outdoors in the sunlight during the daytime and indoors over a 25-watt electric globe at night and the bagasse was regularly sprinkled.

There is every probability that this mating and egg-laying occurred abnormally late in the season. October nights in Louisiana are frequently quite cold with frost occurring occasionally. The clutch of eggs laid last year at the end of July would appear to have arrived at a more natural time than the present one which was laid five weeks later.

The eggs were obviously increasing in size and toward the end of October they appeared as large as small hen's eggs. On October 22 (7 weeks' incubation) one measured 2⅛ inches long and 1⅛ inches in diameter, an increase of about 250% in volume since the day it was laid.

Both lots of the eggs hatched on the same day, October 30. This is noteworthy since they had not been under identical conditions of temperature and moisture. It is difficult to say which set had the higher temperatures, though it is probable that the one warmed by the outdoor sun in the daytime and the incubator light at night was the more favored. Nine snakes hatched from each lot, either during the night or early in the morning. They were smaller than had been expected from the size of the eggs, the largest being 9½ inches long and the smallest 6¼ inches. The combined weight of one group of nine snakes was only 60.5 grams. In conformation and pattern they were strikingly similar to the parent snakes—body fairly stout, tapering evenly both toward the head and the tail; head small and not distinct from the neck, tail ending in a sharp spine. The coloration was shiny black above, black and vermillion checker markings beneath, with the red extending up the sides in triangular blotches. The pattern extended to the tip of the tail giving the appearance of red and black stripes. There was no evidence of the bright yellow color which is pronounced in the male snake under the head and on the side of the lips. Ditmars ("Reptiles of North America") describes young specimens of *Farancia* as having indications of red on the back in the shape of narrow cross bands, but none of this brood showed any such markings. The uniform black of the backs changed in a few hours to the slate-blue color which precedes moulting in adults.

The little snakes were lively and active, burrowing briskly into the moist bagasse which seemed to be to their liking. They refused to stay in tepid water, wriggling out of the pan promptly when they were placed in it. An interesting characteristic was the use of the spine on the tail both to threaten and to attack. They never attempted to bite or to strike but when handled or disturbed they would curl the tail so that the bright red pattern was much

in evidence after which they would sweep the tail about and stab with the diminutive spine. The snakes were so tiny that no sensation was communicated to the hand by this defensive action except where the skin was thin.

Of the eight eggs that did not hatch with the original groups three were considerably shriveled and were thrown away without being opened, four others were found to contain dead embryos while one which was large and full was kept under observation on a bed of moist bagasse in a beaker. This egg first lost its round, full appearance at noon of the day following the hatching and at eight o'clock in the evening a perforation about half an inch long was noted around which there was an ooze of egg-albumen. The small snake protruded its head several times during the evening, drawing it back when disturbed. The following morning, 48 hours after the first group had hatched, it repeated these maneuvers several times and finally emerged from the egg while under observation, burrowing immediately into the bagasse. It proved to be one of the smallest of the brood, 6¼ inches long, but active and well formed.

Seven days later all the specimens shed their skins after going through the color changes characteristic of mature examples of *Farancia*. Feeding is a problem as earthworms do not seem to interest the snakes and small *Amphiuma* are not available at this time of the year.

GRAMERCY, LOUISIANA.

Notes on the Life History of the Striped Bass (*Roccus lineatus*)[1]

By DANIEL MERRIMAN

IN April, 1936, there was started an investigation of the life history and habits of the striped bass (*Roccus lineatus*).[2] This investigation was sponsored by the Connecticut State Board of Fisheries and Game and was undertaken by the author, serving as Aquatic Biologist of the Board.

At the outset it was recognized both by the State Board and by the investigator that only part of the desired knowledge could be obtained by studies in one particular locality—that the problem was essentially interstate. But only fragmentary information regarding the striped bass of the Atlantic coast was at this time available. Furthermore, this fish is of no small interest to both commercial fishermen and sportsmen. It seemed essential, therefore, that at least a start toward the solution of the whole problem should be made.

[1] Printed under a grant from the American Wildlife Institute, for the publication of biological contributions fundamental to fish management.

[2] In connection with the specific name of the striped bass, Jordan, Evermann and Clark (1930) make the following comment in a footnote: "This species is usually called *Roccus lineatus* after *Sciæna lineata* Bloch (Ausländische Fische, VI, 1792, 62); but it can not be the same. The form, serræ of the preopercle, and the stout spines of the fin, as well as the asserted locality ('Mediterranean') indicate that the species concerned is *Dicentrarchus lupus* of Europe. The only resemblance to *Roccus* is found in the striped color; but Bloch says that the stripes on the sides are yellow." In spite of this statement the author feels, as does Scofield (1931), that because *lineatus* has been and is at present much more widely used than *saxatilis*, and because there is apparently still some disagreement among systematists concerning not only the specific name but also the validity of the generic name, it is better, at least until the situation has been clarified further, to refer to the striped bass as *Roccus lineatus*.

Among the common names applied to this species, "striped bass" is almost universally used north of New Jersey, while "rock-fish" is regularly used in the south. The names "green-heads" and "squid-hounds" have been applied in the past to large individuals in New England (Goode, 1884), but are seldom if ever heard now.

The material presented in this paper represents the preliminary results of the striped bass investigation through December, 1936. It should be understood that these findings are in no way final or conclusive, and that they are only a start in the right direction. Regulations intended for the conservation of the striped bass should be based on facts. If they are based on an inadequate knowledge of the life history and habits of the striped bass they will be guess-work and in all probability futile. For this reason the importance of additional research on the striped bass, not only in Connecticut but also in other states along the Atlantic seaboard, cannot be too strongly emphasized.

Acknowledgments

The financing of the investigation during its first 3 months was undertaken by a group of Connecticut sportsmen. From July 1 to December 31, 1936, the Connecticut State Board of Fisheries and Game has provided the necessary funds; it has also made available much of the equipment essential to the progress of the work. Since the author was a graduate student in the Department of Zoology at Yale University during this whole period, the facilities of the Osborn Zoological Laboratory were also at his disposal.

It is next to impossible to single out for thanks certain individuals of the many who have in one way or another given their assistance during the investigation. Without their aid, however, the work could not have gone forward as satisfactorily as it has. But the author is especially indebted to Dr. A. E. Parr, Director of the Bingham Oceanographic Laboratory, who has made many valuable suggestions and has given generously of his time and advice. And to Earl Sisson, who was employed by the State Board to help in the seining and tagging of the striped bass, the writer expresses his appreciation for loyal cooperation. Finally, to his wife, who has done most of the recording and has lent her support in every conceivable way, the author is most grateful.

Range and Review of the Literature

The striped bass has a range on the Atlantic coast, where it is indigenous, from Florida to the Gulf of St. Lawrence. It is most commonly taken in salt water, but its capture in brackish and even fresh water is by no means infrequent.

This fish, as Bigelow and Welsh (1925) pointed out, is strictly coastwise, and records of it being taken more than several miles offshore are scanty. Because of this fact and because of its enormous abundance in times past, mention of the striped bass appears early in American literature. Thus Capt. John Smith (Jordan and Evermann, 1905), William Wood (1635), and others, wrote of the great numbers that were taken by the early settlers.

Turning now to more modern times, we find that mention is made of the striped bass frequently, but in all the literature dealing with the fishes of the Atlantic coast there is scant information on the life history of this species. Standard and such well recognized references as Bigelow and Welsh (1925), Hildebrand and Schroeder (1928), and Jordan and Evermann (1905), sum up well the available knowledge on the striped bass in a few brief pages.

Further than this there is little information at hand for this species on the Atlantic coast.

In the last quarter of the 19th century striped bass were introduced on the Pacific coast, and they prospered so well there that they soon became, and still remain, the object of an intensive fishery conducted by both commercial and sport fishermen. The Division of Fish and Game of California has made careful studies on the life history of the species, and from these studies has come much interesting and valuable information. The outstanding paper on the striped bass in California is that of Scofield (1931). Since, however, the conditions pertaining to the fishery on the Pacific coast differ so much from those on the east coast, much of the information presented by the Division of Fish and Game of California cannot be applied to the striped bass of the Atlantic.

The Evidence for a Decline in Abundance

In discussing the evidence for a decrease in abundance of the striped bass it cannot be too strongly emphasized that this species is a strictly coastwise

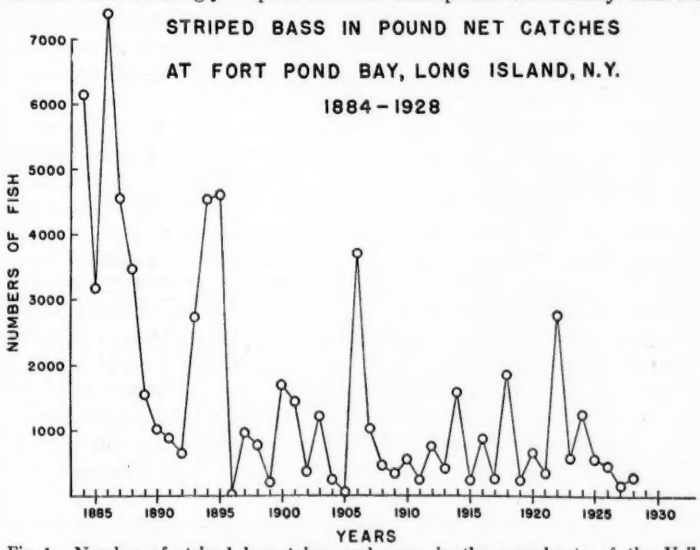


Fig 1. Number of striped bass taken each year in the pound-nets of the Vail family, near Montauk, Long Island.

The number of pound-nets used from 1884 to 1928 by the Vails varied from 6 to 10. The catches shown in this graph have been weighted to make them equivalent to a fishing intensity of 10 pound-nets throughout.

form. If haddock, halibut and other offshore fishes have become scarcer through the intensity of fishing, and this is admitted, how much more likely it is that an inshore species such as the striped bass, which is more accessible and therefore endlessly the object of the fishermen's attention, should soon have shown a marked decline in numbers. Nor is the availability of this species to the fishermen and the resultant heavy drain on the stock the only

factor involved. With a species having such a narrow geographic range there was every chance for modern civilization seriously to harm and perhaps ruin beyond repair valuable spawning areas, and there is abundant evidence to show that such destruction has too often occurred. In view of these facts it was not an unreasonable expectation that the supply should soon have diminished.

Quotations from the early settlers point to the enormous abundance of the striped bass in those times, but Bigelow and Welsh (1925) mention that "a decrease was reported as early as the last half of the eighteenth century." And although there are few catch records or figures to prove the point, there can be little doubt that the decline has continued since then. There have been occasional periods when the catch has soared to exceptional heights due presumably to the presence of unusually good year classes, but these peaks in the records have been short-lived, and the general trend over long-term periods has been steadily down.

In this connection the records[3] kept by the Vail family of the numbers of striped bass caught in their pound-nets in Fort Pond Bay near Montauk, Long Island, at each hauling from 1884 to 1928, are of considerable interest (see Figs. 1 and 2). It is impossible to test the validity of this method of sampling the total population, but there is good reason to believe that the gradual decline these records show is a fair indication of the decrease in abundance. The peaks at 1886, 1894 and 1895, 1906 and 1922, perhaps represent exceptionally good year classes that bolstered the stock temporarily. But bass school heavily, and the presence of one school alone can form the main part of such peaks. Thus in one year the fish might be far less numerous than in others, but a large school that happened to hit the traps would give a false impression of abundance. In another year it is easy to imagine the reverse situation, that is, of the population being unusually high, but of comparatively few bass striking the pounds. It is therefore unwise to attempt to correlate these peaks with other conditions such as temperature or rainfall, or to otherwise interpret them until the records are more complete and the adequacy of this method of sampling can be more accurately determined. The fact that there is some discrepancy between the peak years shown in Fig. 1 and those that Bigelow and Welsh (1925) mention for the catches in Massachusetts Bay indicates that the records leave much to be desired.

It is of no small interest, however, that if the records of the Vail family's traps had been kept from 1928 through 1936, the catch up to 1936 would in all probability have remained at an uninterrupted low level, for catches by other nets in that locality have been consistently small during those years. But there is no doubt that the year 1936 would have shown a peak equal to and perhaps above any other shown in Fig. 1. The enormous numbers of striped bass along the Atlantic coast in 1936 were made up mainly of fish 2 years old, the age at which this species first makes its appearance in the commercial and sport fishermen's catch in these waters. This group of fish is treated in some detail in the section on *Age and Rate of Growth;* a glance at Fig. 4 will sufficiently emphasize the enormous abundance of this year

[3] These records were put at the author's disposal through the courtesy of the U. S. Bureau of Fisheries and the Bingham Oceanographic Foundation.

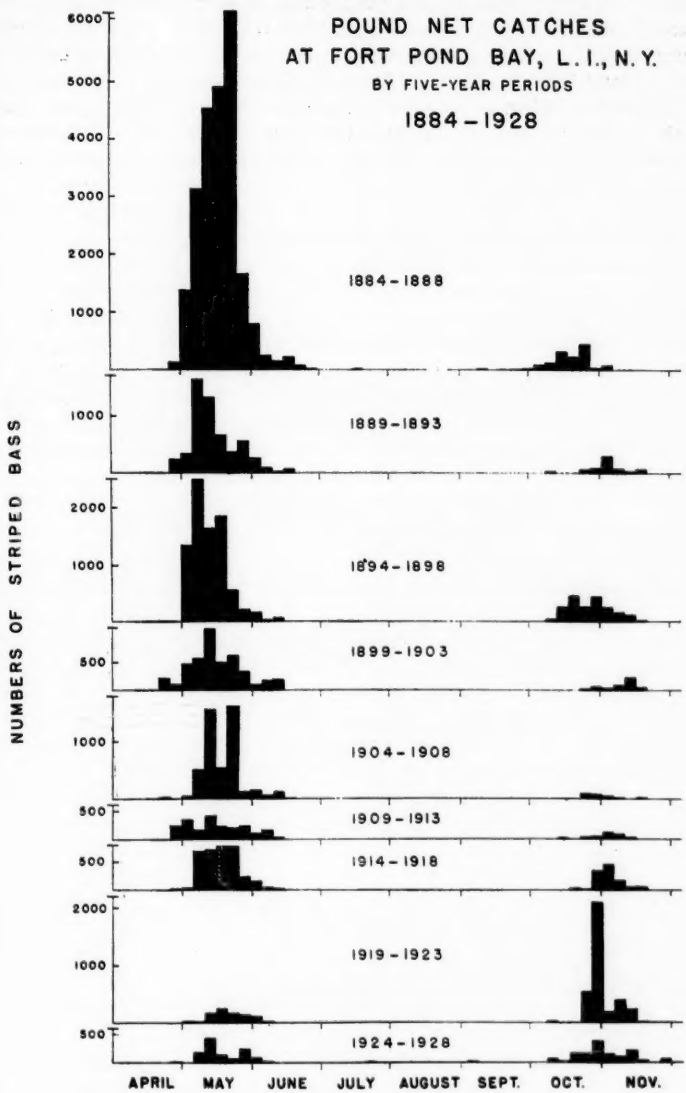


Fig. 2. Number of striped bass caught by the Vail family each 5 days during the fishing season, by 5-year periods.

The catches of the Vail family's pound-nets have been weighted, as in Fig. 1, to make them equivalent to a fishing intensity of 10 pound-nets throughout. Note that the catches are made only in the spring and fall of the year—see under *Migrations*.

class. There is no question that the abnormally high catch records of 1936 were due almost entirely to this group of two-year-old fish, which is a perfect example of the exceptionally successful year classes that make their appearance in most fisheries at varying intervals, thus bolstering a stock even when otherwise decreasing. It is unsafe at present to hazard a guess as to why such eminently successful year classes of striped bass appear, and it can only be said that there occurred in 1934 the perfect concatenation of all the events which go to make spawning, fertilization and development a success.

The existence of this large group of two-year-olds presents an optimistic tinge to an otherwise gloomy picture of decline. But when this picture is viewed over long-term periods and in the light of past records, there is little cause to suppose that the peak reached by this year's catch will be touched soon again. It is better therefore, to think of it as an unusual and abnormal event that will not necessarily recur for some time. It is interesting to note from Fig. 1 that there are sharp declines in the catch records in the years immediately following those in which the peaks are exceptionally high, and it is further of importance to note that in spite of the presence of occasional large year classes, the trend of the whole picture is gradually downward.

Spawning Habits and Early Life History

It has been commonly stated in the literature that striped bass are anadromous, coming in from the sea to spawn in brackish or fresh water. Spawning is said to occur in the spring of the year from April through June, the exact time depending on the latitude and temperature (see Hildebrand and Schroeder, 1928). Thus Smith (1907) in referring to the Roanoke River near Weldon, North Carolina, wrote: "In these rapids, where the muddy current is exceedingly strong and rendered very erratic by islands, boulders, and rocks, the fish spawns." Most statements on the spawning of this species have been based on a series of papers by S. G. Worth (1903 to 1912), in which he discussed the problem of artificial propagation and presents many interesting sidelights on the various phases of spawning and early life history. Although in all his writings most of the information is fragmentary, his observations are still of value because there has been so little recent work on the Atlantic coast to corroborate and amplify his statements. Preliminary work by the author, and especially the capture of baby striped bass (see below), strongly support the conclusions of Worth and others as to the time and place of spawning. On the Pacific coast the work of Coleman and Scofield (1910) and that of Scofield (1931) indicates that striped bass spawn from April through June in the low-lying flooded delta country adjacent to Suisun Bay, where the water borders between brackish and purely fresh.

In discussing the eggs and their development the available information on the Atlantic coast is well summed up by Bigelow and Welsh (1925) as follows: "The eggs (about 3.6 mm. in diameter) are semibuoyant—that is, they sink but are swept up from the bottom by the slightest disturbance of the water—and this is so prolific a fish that a female of only 12 pounds weight has been known to yield 1,280,000 eggs, while a 75-pound fish prob-

ably would produce as many as 10,000,000. The eggs hatch in about 74 hours at a temperature of 58°; in about 48 hours at 67°."

The presence in the brackish waters of large rivers of young fry and small fish offers sound proof that the striped bass is an anadromous species. Thus Mason (1882), Throckmorton (1882), Norny (1882) and Bigelow and Welsh (1925) present interesting accounts of baby bass being taken in various rivers along the coast in the past. Hildebrand and Schroeder (1928) and others record them as being taken in Chesapeake Bay during the summer months.[4] But most significant of all is the fact that the New York State Conservation Department took large numbers of small striped bass (1 inch and longer) in various localities on the Hudson River from Beacon downstream during the summer of 1936.[5] These areas were essentially similar, all of them being shallow bars of sand and light gravel or rocks; the salinity of the water just below Beacon where small bass were first encountered ran from 0.2 to 0.7 parts per 1000. Larger individuals (as large as 2 pounds) have been taken in the Hudson as far up as Albany. There can be little doubt, therefore, that the Hudson River is a spawning area for striped bass, and in view of the evidence presented above it seems safe to assume that this species is truly anadromous, spawning in the spring of the year in water that is at least brackish and perhaps at times entirely fresh.

It is almost certain that the striped bass in early times entered and spawned in every river of any size, where the proper conditions existed, along the greater part of the Atlantic coast, and that as cities were built and dams and pollution spoiled one area after another, the number of rivers that were suitable for spawning became fewer and fewer. Thus in Connecticut, where there is abundant evidence that striped bass used to spawn,[6] there is now every indication that spawning seldom if ever takes place. From April through October, 1936, the author has tried innumerable times in various localities to find evidence that young striped bass are present in Connecticut waters, but invariably with no success. Most attention was centered on the Niantic and Thames rivers, especially the latter, because accounts of baby bass having been caught there within the last 50 years are more numerous than in other regions. Despite the fact that areas similar to those where small bass were taken in the Hudson River in August, 1936, as well as other likely localities, have been worked with minnow seines and small-meshed trawls that were efficient enough to catch large numbers of young fish of many other species and occasionally even adult striped bass, the smallest striped bass taken in Connecticut waters measured 23 cm. (9 inches). If spawning occurred to any great extent, small fish 3–8 cm. long, comparable to those caught in the Hudson, would most certainly have been found. Plankton and bottom hauls taken at weekly intervals in the Niantic River in an

[4] Dr. Vadim D. Vladykov, of the Chesapeake Biological Laboratory, also reports taking many small striped bass 2 to 3 inches in length on the eastern shore of Chesapeake Bay during the summer of 1936 (in a letter to the author dated August 11).

[5] This information was obtained from Dr. Emmeline Moore and her assistants on the Biological Survey on a visit to Poughkeepsie, New York, on August 29, 1936. At this time the author was given a collection of small striped bass, and the details of their capture were placed at his disposal. The area just below Beacon where small striped bass were first caught was also shown the author by Mr. James B. Westman, a member of the River Unit under Mr. H. Wesley Curran.

[6] During the summer of 1936 the author met and talked with not a few old-time fishermen who could themselves either remember seeing small striped bass an inch or two long in Connecticut rivers, or had been told about them by their fathers.

area where bass were known to be present from April through November, 1936, have given much interesting material on the eggs and larvae of other species. But they have failed to reveal the presence of anything that might be construed as evidence that striped bass spawn there. Further than this, not a single ripe fish of this species has been taken by the author during the course of the investigation, and inquiries among local fishermen show that ripe bass have been caught so rarely and at such irregular times in recent years in Connecticut waters that their presence can be considered nothing more than erratic or abnormal. The fact that large fish that showed no signs of even approaching ripeness were taken in the Niantic River during the spring months suggests the possibility that this species is not necessarily an annual spawner. The resultant impression from this information is that spawning does not occur in the region thus far investigated, or that if it does, it is of a most sporadic character. It may be that other Connecticut waters provide proper breeding grounds, but this is considered highly unlikely. As to the Thames River there can be little doubt that the presence of dams, which make it impossible for the fish to get to fresh water, and pollution (although older bass are caught in good numbers in this river), have made the region unfit for the spawning of striped bass and for the development of the eggs and larvae.

Sex and Age at Maturity

Unfortunately it is exceedingly difficult, in Connecticut, to get large quantities of striped bass for the determination of sex or the analysis of stomach contents. There is practically no commercial fishery for the species in this state, and even in adjoining waters where bass are caught in large numbers in the spring and fall, the pound-net fishermen ship their catches to market without cleaning the fish; in Connecticut the few bass which are sold to the markets are also dressed only as they are bought by individual customers. The collection of quantitative data on this phase of the work during the course of the investigation was therefore necessarily limited to the examination of fish caught on rod and line by sportsmen throughout the season (April to November), and to a few small random samplings of bass that were seined primarily for tagging purposes.

Only 308 striped bass were examined for sex; it is of no small interest, however, that 87% of these were females. Of the 49 fish that were 3 years old or more, all were females. Of the remaining 259 bass, all two-year-olds, the 40 males constituted but 15% of the total. Although the number of fish examined for sex is too small to permit any final conclusions on the subject, the author feels that these figures are at least indicative of the existing sex-ratio in Connecticut waters. Such a disproportionate number of females to males is of course most unusual, and it seems a logical assumption that this condition cannot prevail among the total population of the Atlantic coast. Further investigation of this subject in different localities should yield interesting results.

In the investigation of the age at maturity, it soon became apparent that microscopic examination of the gonads presented the only plausible method of procedure, for the fact that ripe individuals were not available in Con-

necticut waters precluded the possibility of studying the age groups making up a spawning population. Gonads from striped bass of all sizes were therefore collected from April through November at intervals of about a week or ten days. These were fixed in Bouin's fluid and slices from the anterior, middle, and posterior region of each one were cleared in toluene.[7] Although this phase of the work is only in its preliminary stages, sectioning and staining, and subsequent microscopic examination, make it appear probable that a few of the female striped bass become mature by the end of their 3rd year, while the majority attain maturity at the end of their 4th year. This agrees well with the results obtained by Scofield (1931) for the striped bass on the Pacific coast.

Age and Rate of Growth

During the course of the investigation scale samples were taken from approximately 2000 striped bass of measured length. All scale samples were taken from the first or second white stripe above the lateral line in the mid-region of the body directly below the gap between the spinous and soft dorsal fins, for it was found that scales from this area were more consistently suitable for study than those from any other place. Of the several scales taken from each individual, from 1 to 3 of the best were mounted on slides in Karo Corn Syrup. Length measurements were made from the tip of the snout to the fork in the center of the caudal fin, for it became evident in handling live fish that were being tagged that measurements to the fork in the tail were easier to make than other measurements and were far less subject to error. A flat measuring board with vertical head-piece was always used, and measurements were made to the nearest half centimeter.

No detailed analysis of the scales has been made as yet, but a sufficient number has been examined to make definite age determinations.[8] As a check on these age determinations the growth rings on the otoliths have frequently been counted. Opercles cleared in a half-and-half mixture of 5% glycerine and 5% KOH have at times shown distinct annuli that further check the accuracy and validity of the age readings from scales.

Since the youngest striped bass taken in Connecticut waters during the course of the investigation were 2 years old it was impossible to make any studies on the earlier stages. The two-year-old fish in Connecticut averaged 28 or 29 cm. long in the spring and were approximately 38 cm. long by late October, but, like the fish of other ages, varied considerably in length from the mean size at any particular time. The growth of the two-year-olds is well shown in the length frequency curves for each month from June through October (Fig. 3). It will be noticed from this graph that the growth is comparatively slow in the spring and early summer, that it speeds up during August and September, and that it is greatest, despite the sharp drop in temperature (Fig. 7), in October. Since the temperature fell sharply in the fall, the normal expectation would be that the increase in length would have been less than in the preceding months, if the food supply had remained

[7] Oil of wintergreen and other clearing agents were also used at first, but in general, toluene gave the most satisfactory results.

[8] Scales from over 600 individuals have been carefully studied thus far. It is the author's intention to follow this paper with another dealing with a detailed analysis of striped bass scales.

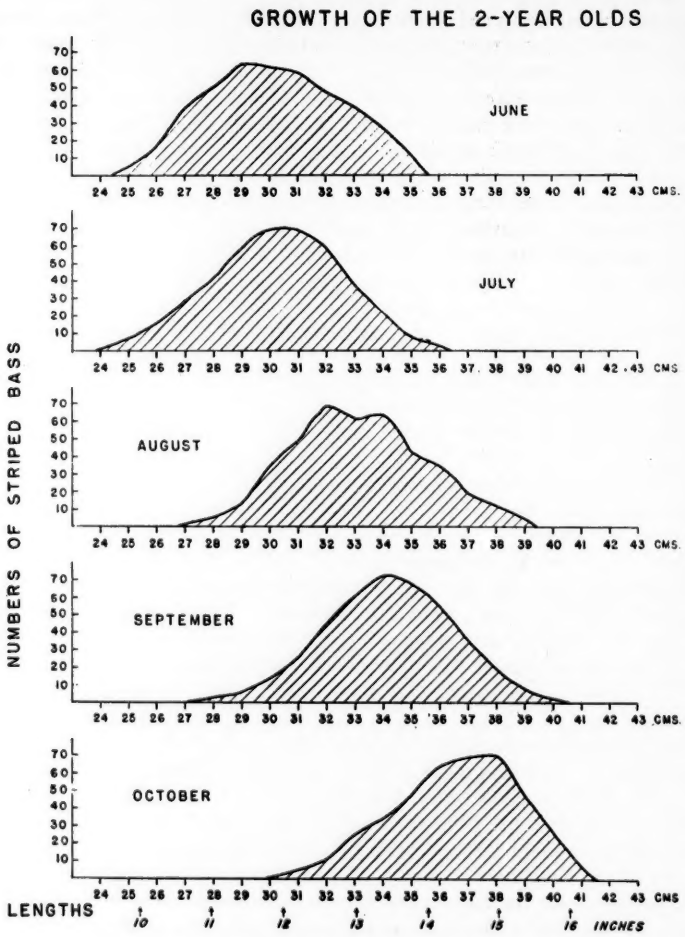


Fig. 3. Growth of two-year-old striped bass in Connecticut, in 1936.
The numbers of fish making up each one of these length frequency curves have been weighted to make each total equivalent to the greatest number measured in one month. This month was September, when the lengths of 415 striped bass were taken. The curves have been smoothed by a moving average of threes.

constant over the same period. There is, however, some evidence that the food supply or its availability increased. The analysis of the stomach contents of the striped bass is discussed in a later section of this paper, but for the present it is interesting to consider the fact that this species is voracious in it feeding habits and that it preys on small fish, paricularly young menhaden (*Brevoortia tyrannus*) and shiners (*Menidia menidia notata*). Both of these species spawn in the spring and early summer, and during July the

young are still so small that they do not form a large part of the diet of the bass, but by late summer and particularly early fall they have increased in size to such an extent that they have added enormously to the available food supply. Furthermore, young menhaden were unusually abundant in Connecticut waters in the latter part of 1936, and the analysis of the stomach contents during September showed that striped bass continually gorged themselves on these small fish to the virtual exclusion of other types of food. Two other explanations of the apparently greater rate of growth in October are suggested by the skewness of the size frequency curve for that month. In the first place, the shape of this curve is conceivably the result of "compensatory growth," which Watkin (1927) has shown to be characteristic of the herring, namely, the phenomenon of the smaller fish of a single age group making up a deficiency in size between themselves and the larger fish

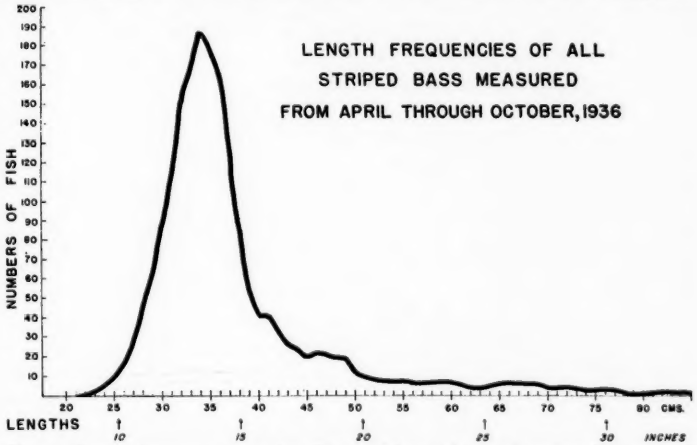


Fig. 4. Length frequency curve for all striped bass taken and measured from April through October, 1936.

The number of fish making up this graph is 2000, 65% of which are two-year-olds This curve has been smoothed by a moving average of threes.

of the same group in a relatively short period after having lagged behind for some time. Another contingency that cannot be overlooked is that while the striped bass population remained the same in the waters under investigation during the summer, it had started to change by late October (see under *Migrations*), with the resultant possibility that a slightly larger group of fish may have been included in the length measurements near the end of the month, thus giving additional and undue weight to the higher end of this growth curve. However, the returns of tagged fish that had been measured at the time they were released and were again measured when they were caught not only indicate that a greater amount of growth actually occurred in October than in the earlier months, but consistently agreed well with the growth of the two-year-olds as shown in Fig. 3.

It was impossible to obtain a sufficient number of measurements of striped bass more than 2 years old to construct length frequency curves by months

for these age categories, or even to indicate adequately the length-weight relationship (Fig. 5) for the larger and older fish. Three-year-old striped bass, however, averaged about 40 cm. in the spring and 46 cm. by October, while four-year-olds ranged from 48 to 53 cm. over the same period of time. But there was a tremendous variation about the mean in these measurements and the subject is further complicated by the fact that the population under investigation was undoubtedly composed of stocks from widely different areas (see under *Migrations*), perhaps with varying growth rates. Until a more detailed scale analysis is carried out in conjunction with the length frequency studies, any statements on the growth of striped bass more than 2 years old must therefore necessarily rest on an extremely insecure foundation.

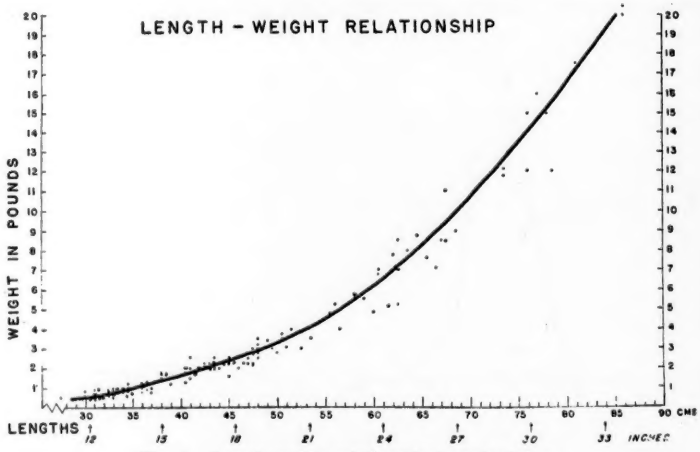


Fig. 5. Length–weight relationship in striped bass.
The number of fish making up this length–weight curve is slightly over 200.

During 1936 more striped bass were caught by both commercial and sport fishermen, as has been pointed out before, than in any other recent year. That this increase in numbers was due solely to the presence of an enormous group of two-year-old fish there can be no doubt. Fig. 4 is a length frequency curve of all the striped bass measured in Connecticut waters during the course of the investigation from April through October, 1936. The measurements that make up this graph come mainly from seined individuals, but they also come from fish that were caught on rod and line and in pound-nets. Although this method of sampling the total population cannot be entirely free from error, it is probable that this curve represents the relative proportion of each age group to each other fairly accurately. The tendency of this species to school heavily at certain size categories, particularly when small, making them more available and easier to catch, may have resulted in an over-emphasis on the relative number of young striped bass in 1936. And the fact that extremely large striped bass tend to lie among the rocks in or near the surf in places where they cannot be reached by

seining perhaps provides reason to suppose that these larger fish[9] are not proportionately represented in this graph. But both of these possible errors are considered to be so small, that the tremendous peak of two-year-old fish which make up 65% of the total number measured does not seem to be an inaccurate representation of the relative abundance of this age group.

Migrations

The tagging of striped bass was started in April and continued through October, 1936, during which time a total of about 1400 marked individuals were released. The great majority of these were caught in a seine in the Niantic and Thames rivers, Connecticut, although a considerable number were also successfully tagged after being caught on rod and line. A few marked fish were released in the Lieutenant and Connecticut rivers. The so-called "button" tags[10] have been used at all times, and with this species of fish they have been shown to be efficient and highly practical. A single tag consisted of two discs of red celluloid, each .025 inch in thickness and 0.5 inch in diameter with a center hole $\frac{1}{32}$ inch in diameter, and each bearing the same number and the words, RETURN TO FISH & GAME, HARTFORD, CONN., in black print. The discs were attached to the fish by means of a pin, the pointed end of which was inserted through the flesh between the two dorsal fins and then crimped over with a pair of pliers in such a way that both discs fitted closely against the sides of the back of each fish, but with ample space to allow for growth. Two types of pins were used; those tried with the first 500 bass were stainless steel insect pins, while those used on the remaining 900 individuals were of No. 20 gauge B. & S. pure nickel. The stainless steel pins were on the whole unsatisfactory, and there was abundant evidence from the subsequent recapture of fish that still showed a scar from the insertion of the pin but had lost the tag, that they did not last properly in salt water. Not only did they become brittle and fragile after some time, but their too thin shafts showed a distinct tendency to cut through the flesh, thus allowing more room for the movement of the tags and often creating small sores. All these difficulties were obviated by the use of the thicker-shafted non-corrosive nickel pins.

Length measurements were made and scale samples taken from every striped bass that was tagged, and the date and locality were always recorded.

Although there are no accounts in the literature of the migration of striped bass on the Atlantic coast,[11] there was much evidence before tagging was started to show that this species makes definite seasonal movements of considerable magnitude. Analysis of the catch records of the pound nets at

[9] In discussing the age and growth of the striped bass, it is of interest to mention the maximum size which these fish reach. Bigelow and Welsh (1925) give accounts of one of 125 pounds being taken at Edenton, North Carolina, in 1891, and another of 112 pounds at Orleans, Massachusetts. In connection with their age, Bigelow and Welsh wrote: "they are certainly long-lived, for one kept in the New York Aquarium lived to an age of about twenty-three years." Nowadays bass weighing more than 60 pounds are a rarity, although one weighing 65 pounds was taken in Rhode Island in October, 1936. A rough estimate of its age from the examination of several scales leads the author to believe that this fish was about 30 years old.

[10] This type of tag was used at the suggestion of Mr. Robert A. Nesbit of the U. S. Bureau of Fisheries. It is actually a modification of the Scottish Plaice Label, the main changes consisting of reduced dimensions, the use of celluloid instead of hard rubber, the addition of printing, and the substitution of nickel pins for silver wire as the method of attachment.

[11] Recent tagging experiments on the striped bass have, however, been carried on in California (Clark, 1936), and the results have shown that there were "no definite migrations, simply a diffusion from the locality in which the bass were tagged."

Montauk, Long Island, New York (see Fig. 2), and Newport, Rhode Island, shows that striped bass are caught in large quantities only in the spring and fall of the year. Further than this, the date of capture of striped bass in pound nets and seines in great numbers in the spring along the Atlantic coast from Maryland to Massachusetts is progressively later the farther north

TABLE 1. RETURNS OF TAGGED STRIPED BASS BY MONTHS IN 1936

Month and total number tagged by end of the month	Original point of release	Number of returns during each month	Locality of recapture
May 121	Niantic River, Conn.	2	Niantic River, Conn.
		2	Thames River, Conn.
		3	Point Judith, R. I.
		1	Newport, R. I.
		8	
June 331	Niantic River, Conn.	17	Niantic River, Conn.
		3	Thames River, Conn.
		20	
July 483	Niantic River, Conn.	9	Niantic River, Conn.
		1	Niantic River, Conn.
		1	Thames River, Conn.
		11	
August 792	Niantic River, Conn.	3	Niantic River, Conn.
	Thames River, Conn.	2	Thames River, Conn.
		5	
September 1217	Niantic River, Conn.	70	Niantic River, Conn.
	Thames River, Conn.	3	Thames River, Conn.
		73	
October 1397	Niantic River, Conn.	30	Niantic River, Conn.
	Thames River, Conn.	2	Niantic River, Conn.
	Thames River, Conn.	1	Thames River, Conn.
	Niantic and Thames rivers, Conn.	30	Montauk, L. I., N. Y.
		4	S. Shore of L. I., N. Y.
		67	
November 1397	Thames River, Conn.	3	Niantic River, Conn.
	Niantic River, Conn.	4	Niantic River, Conn.
	Niantic and Thames rivers, Conn.	55	Montauk, L. I., N. Y.
		7	S. shore of L. I., N. Y.
		69	
December 1397	Niantic and Thames rivers, Conn.	1	Montauk, L. I., N. Y.
		1	Bradley Beach, N. J.
		2	Rehoboth Beach, Del.
		2	Chesapeake Bay
		1	Manns Harbor, N. C.
		7	

these catches are made. It therefore appeared logical, before tagging was started, to suppose that large schools of striped bass migrate north along the Atlantic coast at least from Chesapeake Bay to Massachusetts in the spring, and that they show a corresponding return to the south in the fall.

Returns from the 1397 individuals tagged from April through October reached 260 (18.5% of the total) by the end of December, 1936. They gave abundant proof that an eastward extension from Connecticut to Rhode Island of what probably was a mass migration to the north reached its peak during May in southern New England waters, and that a return to the south starting in late October and continuing on through November definitely took place (see Table 1 and Fig. 6). During late April and May only a few striped bass were tagged, yet returns from the Thames River, Connecticut, and Point Judith and Newport, Rhode Island, where a large number of traps or pound-nets confront any fish with migratory tendencies, proved that many of these fish were taking part in what the spring catch records of these traps had suggested to be a tremendous mass movement to the north. Fish tagged in the Niantic River, Connecticut, were returned from Point Judith and Newport, a distance of 40 to 50 miles in a straight line, 5 to 7 days after their release. During the summer and early fall the striped bass population in the Niantic and Thames rivers remained relatively stable. Only minor migrations and movements up to 10 miles from the original point of release were recorded, and it is significant that there were no returns from localities to the south and west of the areas in which striped bass were tagged. The stability of the population through the summer and up to the latter part of October was shown by the consistent recapture of tagged fish at or near the localities where they were released. An extreme example is that of fish No. 197, which was seined, tagged, and released in June in the Niantic River, caught in a trap in Niantic Harbor in July and released, caught on rod and line in the Niantic River in September by the author and released, and caught and released again while seining for tagging purposes in the Niantic River in early October. The first indication that a migration to the south was starting came in late October when two fish tagged in the Thames River were recovered in the Niantic, and although these fish had only moved about 10 miles, they were the first that had ever been taken to the south and west of the original point of release. Shortly thereafter tagged striped bass began to be caught in large quantities in the pound nets at Montauk and on the south side of Long Island where they were taken in seines and on hook and line. The number of returns from Montauk reached a peak during the first 10 days of November. During December scattered returns of tags from New Jersey, Delaware, the entrance to Chesapeake Bay, and one from North Carolina, have shown that striped bass may go great distances on their migration to the south in the fall.

Thus the evidence from the catch records and these tagging experiments favors strongly the idea that there is a mass migration, at least past Rhode Island and Long Island, to the north in the spring and to the south in the late fall. These movements do not, however, include all striped bass, for this species is caught in southern waters in the summer, as well as in northern

waters in the winter, and the results of preliminary scale analysis appear to show that a small percentage of the fish that were taken in Connecticut waters from April through October had at one time or another been permanent winter residents in this region. The impression created from the material at hand to date is that the migrations of the striped bass have their

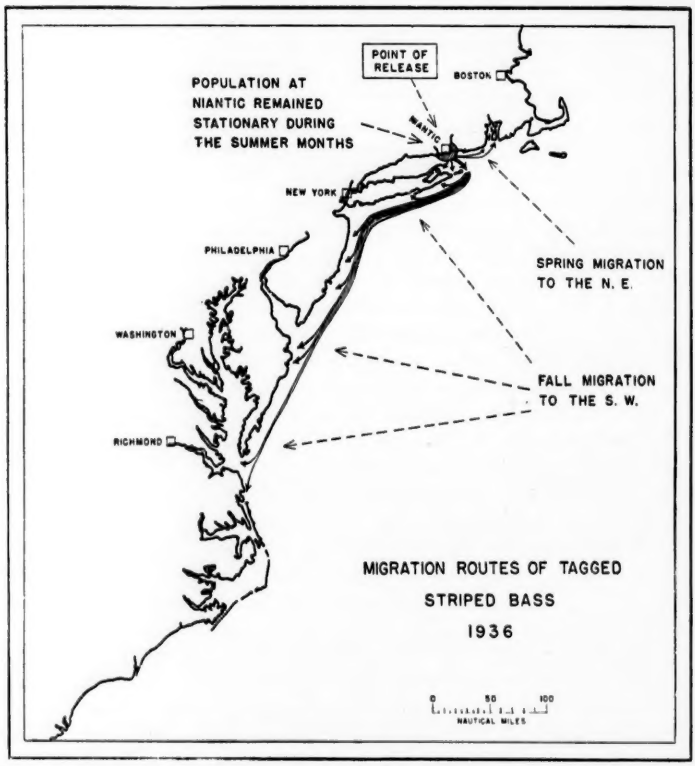


Fig. 6. Chart of the Atlantic coast showing the migrations of the striped bass as determined from the 18½% returns by December, 1936, of the 1397 individuals tagged from April through October, 1936.

maximum size and intensity along the southern New England and Long Island shores, and that the farther south the fall movement goes the smaller it becomes, as individuals and groups split off from the main lot to winter in different localities; conversely, starting from the south in the spring, the numbers making up the mass migration northward become greater and greater as the movement proceeds up the coast, being progressively augmented by fish that have wintered farther to the north.

In 1936 the exceptionally large number of two-year-old striped bass previously discussed formed the main part of the north and south migrations,

and it is of considerable interest to note that there is much evidence to support the conclusion that they came in the main from the Chesapeake Bay region.[12] In the summer of 1935, when these fish were one-year-olds and probably averaged about 15 cm. long, an unusually great abundance of striped bass of about this size and presumably of this age was observed and reported from Chesapeake Bay by many people. On the other hand, diligent inquiry elicited no reports of bass of this size in 1935 from waters farther to the north. In the light of these observations it therefore seems logical to suppose that this large group of fish that were two-year-olds in the summer of 1936 had as its point of origin the Chesapeake Bay area. The fish 2 years old are probably the youngest to take any large part in the migrations.

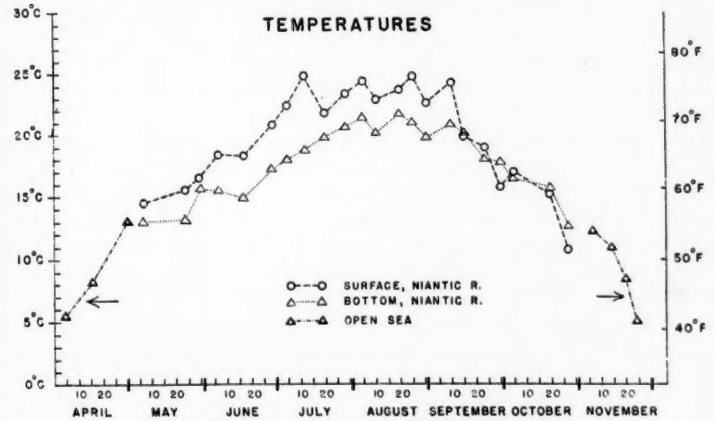


Fig. 7. Water temperatures at Niantic, Connecticut.

The surface and bottom temperatures were taken in an area where striped bass were caught throughout the season. The open sea temperatures were taken at the mouth of the Niantic River, where the water passes through a narrow gut on the incoming tide with such force that the surface and bottom temperatures are the same. The open sea temperatures were taken during the spring and fall migrations of the striped bass. Arrows indicate when the first and last bass of the season were caught.

The question as to how much temperature influences the migrations of the striped bass is one on which there is little evidence. It is perhaps of some significance, or may be a coincidence, that the first striped bass arrived in the Niantic River in April and the last ones departed in November (Fig. 7), at times when the temperature of the water was approximately the same (6.5° to 7.0° C.). The fall of 1936 was characterized by sudden sharp drops in temperature, and during October and early November it was plainly indicated that with each cold snap and resultant decline in the temperature of the water, the striped bass in the Niantic moved out and their place was almost immediately taken by a new wave of fish that presumably came from farther up the coast. This change in population was observed on at least two occa-

[12] It is unfortunate that striped bass are not subject to racial analysis on the basis of vertebral counts, since they have only 25 vertebrae (including the hypural), and like other species with this low number, show practically no variation. Scale and fin-ray counts may possibly be of some use in this respect. Preliminary counts on 50 individuals in Connecticut waters gave the following results (numbers indicate the extremes of variation): dorsal rays, IX–11 to 14; anal rays, III, 10 to 12; pelvic rays, I, 5; pectoral rays, 15 to 17; scales, 8 to 9–57 to 65–12 to 15. Counts of the gill-rakers on the first arch gave an average of 10+1+14.

sions, both immediately following sharp drops in temperature. The first happened when the fish tagged during the summer suddenly ceased being caught as they had been for several months past and shortly thereafter began to appear in the traps at Montauk; their place was quickly taken by an entirely different group of fish that were nearly all two-year-olds and so much fatter than their predecessors that they were easily distinguished as being a new group. The second occasion happened several weeks later, when these fat two-year-olds disappeared and their place was in turn taken by a group of bass that were mainly three-year-olds.

It is of some interest to note that although a considerable number of large striped bass weighing from 5 to 25 pounds were tagged, there have been no returns from these fish save in the immediate locality at which they were released. Returns of tagged fish from any other point than the Niantic River have been confined strictly to two- and three-year-olds. It is difficult at the present time to account for this circumstance, and although it may be that the larger striped bass did not take as great a part in the migrations as the younger individuals, information as to the size categories appearing in the catches of the pound-nets in previous years does not make it appear likely that this is a satisfactory explanation. By the same token, it seems improbable that the larger fish migrate into waters farther offshore, thus reducing the chances of their being caught in pound-nets and seines. Better reasons for the lack of returns of the larger tagged fish are, first, the overwhelming abundance of the smaller striped bass in 1936, and second, the tendency of the two- and three-year-olds to school heavily, thus making them much more available to commercial fishermen than the larger individuals which are not so strongly inclined to congregate together. The heavy schooling of the smaller fish was observed many times during the course of seining for tagging purposes in 1936. That these schools tend to travel considerable distances without breaking up is suggested by the recapture on several instances at the same time and in the same trap in the Montauk region of 2 or 3 fish that had previously been tagged in one seine haul in the Niantic River.

Feeding Habits

The stomach contents of over 250 striped bass all taken in Connecticut waters were examined from April through October, 1936. Of this number of fish the great majority were caught on rod and line; the others were taken in a seine. It is of some interest to note that 41% of all the stomachs examined were completely empty. This high percentage may perhaps be explained first by the fact that this is a species whose intensely rugous lining of the stomach indicates a rapid rate of digestion, and second because the striped bass is apparently not a steady feeder, but commonly gorges itself over short periods of time and then stops feeding until its stomach is completely empty again—a habit that makes its capture by rod-and-line fishermen most likely when it is starting to feed and when its stomach is empty. Evidence that the members of a single school of striped bass often feed simultaneously and then digest their food over approximately the same period of time is seen in the fact that stomach-content analyses of fish taken in the same seine hauls

often showed the food to be in similar states of digestion; thus all the bass in some hauls were gorged with recently taken menhaden, the bass in other hauls had partially or well-digested food in their stomachs, and those taken together at other times were nearly all empty.

The examination of stomach contents has confirmed the commonly held view that the striped bass is voracious in its feeding habits, and has also made it clear that this species often feeds off the bottom. Bass in Connecticut waters feed abundantly on small fish of different species, but blind individuals that were frequently taken in the Thames River apparently manage well only by feeding on bottom-dwelling forms. There follows a list of the animals found in the stomachs of striped bass to date.

Most common types of food:
- Shiners or Silversides (*Menidia menidia notata*)
- Menhaden (*Brevoortia tyrannus*)
- Shrimp or Prawns (*Palæmonetes vulgaris*)

Less common types of food:
- Blennies (*Pholis gunellus*)
- Herring (*Clupea harengus*)
- Mummichogs or Killifish (*Fundulus heteroclitus* and *majalis*)
- Squid (*Loligo pealei*)
- Sand Worms (*Nereis virens*)[13]
- Blood Worms (*Glycera dibranchiata*)[13]

Rare types of food:
- Sand Launces (*Ammodytes americanus*)
- Flounder (*Pseudopleuronectes americanus*), of small size
- Crabs (2 species, neither identified)
- Clams (*Mya arenaria*), of small size
- Snails (*Littorina* sp.?)
- Amphipods
- Isopods

Discussion

It is apparent that the preliminary notes presented in this paper represent only a small part of the life history of the striped bass, and the need for additional knowledge at the present time cannot be too strongly emphasized. A consideration of the great intensity of the fishery as illustrated by the high percentage of returns of tagged individuals will perhaps serve to make this point clear.

Since the type of pin that was used on the first 500 striped bass that were tagged proved to be unsatisfactory, it is better for purposes of this discussion to disregard these fish altogether, and to deal only with the last 900 marked individuals which were tagged from August 19th to October 27, 1936. There had been a 25% return of the two-year-olds in this group by the end of December, 1936. There are, however, two factors which indicate that the fishery accounted for much more than 25% of the two-year-olds in 1936. The first is that these last 900 fish were tagged after the northward migration in the spring, at which time enormous catches of the two-year-olds were made by the pound-nets; the second is that no reward was offered for the return of tags, thus making it likely that a considerable number were not

[13] These two marine annelids are frequently used for bait, and therefore pieces of them are often found in bass that are caught on rod and line; but whole individuals have also been observed on rare occasions in the stomachs of striped bass.

reported. On the other side of the picture it must in all fairness be pointed out that the tagged fish were liberated in an area that was subject to a particularly heavy rod-and-line fishery, and also that many striped bass undoubtedly summer farther to the south where they do not encounter such traps as those located in New York and Rhode Island. But these factors probably do not carry as much weight as those which indicate that more than 25% of this age-group had been taken by December, 1936. An estimation that one-quarter to one-third of the two-year-olds had been caught during their first nine months at a size sufficient to enter the fishery, seems therefore to be justified by the facts.

The seriousness of this rapid depletion of the younger fish is evident when it is considered that the majority of the female striped bass do not apparently mature and spawn for the first time until the end of their 4th year. And it also becomes more than ever obvious why an exceptionally large year-class such as the two-year-olds of 1936 fails to bolster the existant stock to any appreciable extent over long-term periods. The almost immediate obliteration of the surplus created by these large year-classes perhaps accounts, too, for the abrupt return to the normally low level of the catch records (Fig. 1) in the years that directly follow those in which unusually great numbers of striped bass were caught. In the light of these observations it is apparent that the prolific reproduction of the striped bass is the only factor that has prevented the stock from being depleted to an even greater extent.

It is too early to make definite recommendations for the conservation of this species, but there are a few points in this connection that may well be brought out at this time. In the first place, there can be no doubt that the pound-nets or traps in southern New England and Long Island waters, particularly at Newport and Point Judith, Rhode Island, and Montauk, New York, account for the great majority of the striped bass taken in this general region. Rod-and-line anglers in the Niantic River, Connecticut, which is more heavily fished by sportsmen than most waters, caught approximately 12,000 to 15,000 pounds during the whole season (April to November) of 1936; a single trap in Rhode Island took 90,000 pounds of striped bass in two weeks during the fall migration to the south (October 27 to November 10) in this year. It therefore appears logical that if additional investigation corroborates the facts presented in this paper, and if sound regulations to govern the striped bass fishery for the conservation of this species are to be enacted, the possibilities of restricting these enormous catches of young bass should be studied at the earliest opportunity.[14]

It is also evident from the results of the tagging experiments that the problem of conservation is definitely interstate in its scope, and that laws enforced in one area and not in another are likely to be discriminatory and inadequate. Either complete cooperation between the states of the Atlantic seaboard or federal regulation is therefore essential. And finally it is apparent that the solution of all the phases of the life history of the striped bass can-

[14] In this connection it is of interest to note that in California, where the abundance of the striped bass has been maintained despite the tremendous intensity of the fishery, the fish are allowed to attain an age of four years (and a length of 20 inches) before they can be taken legally.

not be accomplished by one state or in one place, and that one or more investigations designed to study conditions in different localities should be undertaken.

Summary

1. The material in this paper presents the preliminary results of an investigation of the life history and habits of the striped bass (*Roccus lineatus*). This investigation was sponsored by the Connecticut State Board of Fisheries and Game, and carried on from April 1 to December 31, 1936.

2. A review of the literature on the striped bass shows that there is scant information on its life history except on the Pacific coast, where it was planted and has prospered to such an extent that it has formed the basis for an intensive fishery since the end of the 19th century.

3. The striped bass has a range on the Atlantic coast, where it is indigenous, from Florida to the Gulf of St. Lawrence. It is a strictly coastwise form. As a result there has been a heavy drain on the stock, and there is much evidence that there has been a serious decline in abundance.

4. In the light of past and more recent observations along the Atlantic coast there can be little doubt that the striped bass is anadromous, and that spawning occurs in the spring. There is no evidence, however, that this species spawns in Connecticut waters at the present time, although there is good reason to believe that it did in the past.

5. Sex determinations on over 300 striped bass taken throughout the season show that 87% were females. The preliminary investigation of the age at maturity makes it appear probable that a few of the female striped bass spawn for the first time at the end of their third year, while the majority attain maturity by the end of their fourth year.

6. Length measurements have been made on over 2000 striped bass, and scale samples have been taken from each fish; otoliths and opercles have been studied at frequent intervals to check the accuracy of the scale readings. No detailed analysis of the scales has been made as yet, but a sufficient number have been examined to make definite age determinations.

7. The youngest striped bass taken in Connecticut waters were two years old. The first of this age, however, comprised an exceptionally large year class and were so abundant as to make it possible to obtain valuable information on their growth rate from June through October. They grew approximately 9 to 10 cm. in this period. The material for the study of the growth rate of older bass is still inadequate.

8. Returns from nearly 1400 striped bass tagged from April through October reached 18½% of the total by the end of December, 1936, and gave abundant proof that a migration to the north reaching its peak in southern New England waters in the spring and a return to the south starting in late October and continuing on through November definitely took place. The most northern recapture in the spring was at Newport, Rhode Island, and the most southern in the fall was in Albemarle Sound, North Carolina.

9. The analysis of the stomach contents of over 250 striped bass has shown that this species is voracious in its feeding habits. Shiners (*Menidia*

menidia notata), menhaden (*Brevoortia tyrannus*) and shrimp (*Palæmonetes vulgaris*) form the most common types of food in Connecticut waters.

10. The high percentage of returns of tagged individuals showed that one-fourth to one-third of the two-year-olds had been caught during their first 9 months after reaching a size sufficient to enter the obviously very intense fishery. The conservation of this species is definitely an interstate problem, and one or more investigations designed to study conditions in different localities should be undertaken at the earliest opportunity.

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Furunculosis in Wild Trout[1]

By Frederic F. Fish[2]

FURUNCULOSIS, or as it has been more appropriately termed, "fish septicemia," is a disease primarily affecting salmon and trout. It is caused by the invasion and growth of *Bacterium salmonicida* Emmerich and Weibel, a Gram negative, non-spore forming, diplobacterium belonging to the family Bacteriaceae Cohn. After gaining entrance to the host, presumably by way of the digestive tract, the organism is spread by the blood stream and produces focal necrosis and subsequent liquefaction throughout the tissues. The more conspicuous gross lesions are those of the body musculature, characterized by the formation of deep seated "boils" or "bloody blotches"—blisters filled with liquefied muscle tissue and blood. Under favorable conditions, the muscle lesions enlarge rapidly and eventually rupture through the skin producing a characteristic, ragged, deep, undermining type of ulcer. Although the muscle lesions are most conspicuous, essentially the same progressive necrosis and liquefaction are to be found throughout the internal organs, particularly in the spleen and kidneys. The host has no adequate defense mechanism against this disease and no verified recovery from furunculosis has ever been recorded. Cases may be arrested by low water temperatures or other adverse factors, only to break out with renewed vigor when conditions again become favorable. The reader is referred to Plehn, Davis, Williamson, and Duff and Stewart for a more complete description of furunculosis.

Furunculosis was originally described from hatchery fish in Germany by Emmerich and Weibel (1894). Following their description, the disease was apparently commonly recognized in German trout hatcheries and it was believed to be a strictly hatchery disease. Plehn dispelled such a belief in 1909 by finding furunculosis among wild fish in the province of Bavaria. Extensive studies by this author in 1909 and 1910 revealed the disease to be present in wild trout taken from 25 rivers and streams of that province. Shortly thereafter, furunculosis was found in other parts of Germany and in Switzerland, Austria, and France as well. The disease was first observed in Great Britian among mature salmon taken from 4 rivers of southwestern England in 1911 by Masterman and Arkwright. Three years later, it was found among salmon in Ireland by Mettam. Studies by the British Furunculosis Committee, appointed in 1929 to investigate the disease, revealed furunculosis to be present in many watersheds of the British Isles.

The first definite proof that furunculosis existed in the western hemisphere was offered by Marsh, 1902, who found it to be the cause of an epizootic among hatchery fish in Michigan. It has since been found at many trout and salmon hatcheries throughout the United States. Furunculosis was recently described from wild Rocky Mountain whitefish, Dolly Varden, and cutthroat trout of the Elk River in southeastern British Columbia by Duff and Stewart, 1933.

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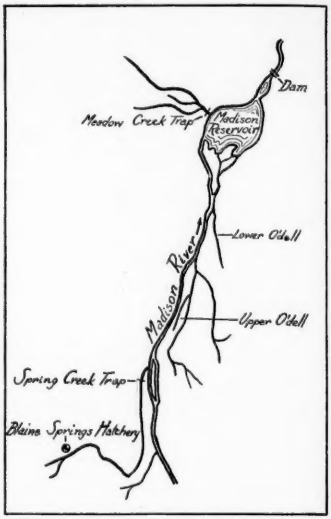
[2] The author is indebted to Mr. Fred J. Foster, Regional Director of the Division of Fish Culture, U. S. Bureau of Fisheries, and to Mr. H. L. Johnston, Superintendent, U. S. Fisheries Station, Bozeman, Montana, for their generous cooperation.

Furunculosis has never been described from wild fish in the United States. It has been found among fish living in streams (Salyer, 1934) but for no report could the possibility be eliminated that the infected fish may have acquired its infection prior to recent liberation from a hatchery. It is of considerable interest that furunculosis has been recently found in adult Loch Leven (brown) trout of the Madison River. Circumstances indicate that this is not merely a hatchery epidemic transplanted to wild waters, but the true establishment of the disease among wild stock.



The Madison River rises in the Yellowstone region of northwestern Wyoming, flows generally northward and joins the Jefferson and the Gallatin at Three Forks, Montana, to form the Missouri River. The central portion of this river, as shown on the accompanying map, is the scene of extensive fish cultural operations.

During the spawning season of the Madison River Loch Leven trout in November and December, 1935, 2 specimens of adult Loch Leven trout were forwarded on ice to the Bureau's Pathology Laboratory at Seattle, Washington. The disease was immediately diagnosed as furunculosis and confirmed by the recovery of an organism in pure culture from both specimens yielding the following cultural characteristics:

Gram negative
Cocco-bacillus, some diploid
No spores
Growth on agar: greyish brown, beaded, brown pigment produced
Growth in broth: light brown, viscous, brown pigment produced
Gelatin liquefied
Starch hydrolysed
Litmus milk: no reaction
Carbohydrate reactions:
  maltose: acid and gas
  glucose: acid and gas
  sucrose: slight acid, slight gas
  lactose: no acid, no gas
Nitrates reduced
Indol not produced
Pathogenic: intraperitoneal inoculation in western cutthroat trout
Identification: *Bacterium salmonicida*

Mr. H. L. Johnston, Superintendent of the U. S. Fisheries Station, Bozeman, Montana, contributed valuable field observations on furunculosis as it occurred in the Madison River (see accompanying sketch map). In so far as known, the first appearance of the disease was in Loch Leven trout at the Spring Creek trap in 1931. It was also observed the following year at Lower O'Dell Creek and at Upper O'Dell Creek in 1934. During the past year

(1935) one infected fish was taken at the Meadow Creek Trap. Mr. Johnston estimated that about 10% of the spawning Loch Leven trout which came into the traps at Spring Creek and Lower O'Dell Creek during the 1935 egg taking operations were infected. The incidence of infection at Upper O'Dell Creek ran considerably lower and was estimated to be 3%. As some 20,000 fish were handled during the spawn taking, apparently a rather large number of fish in this portion of the Madison River are infected. The infections seemed more prevalent during the early part of the egg taking season, when the water temperature was 50° F. Infected fish were exceedingly scarce at the end of the fish cultural operations when the water was barely above the freezing point. The Loch Leven trout appeared to be the only game fish affected by the disease, although "boils" on the Rocky Mountain whitefish and on suckers have been reported by anglers during the fishing season. This part of the Madison River is also inhabited by rainbow trout and by a few eastern brook trout. No infections were reported from these species.

The source of the Madison River furunculosis is conjectural but there is little reason to suppose that the disease is native to this river system. It is not improbable that the disease was introduced by the liberation of infected hatchery fish. Between 1924 and 1933, Loch Leven eggs were collected from wild fish of this region, incubated at a sub-station located at Meadow Creek, and the resulting fry liberated in the river soon after hatching. In 1933, a hatchery was built at Blaine Springs and since that time, the fish have been reared to an average length of 3 inches before liberation. While fingerling fish exhibiting gross lesions of furunculosis have been taken from the rearing ponds at the Blaine Springs hatchery, wild fish probably infected the hatchery stock rather than vice versa for the disease had been observed in the Madison River before this hatchery was built. It is possible that all the infected fish in the Madison River have been hatchery fish which received their inoculum during their brief hatchery life and that the disease has remained dormant in these hosts until maturity. It is more probable, particularly in view of the apparent increasing distribution of the disease since 1931, that furunculosis has established itself among the wild fish.

Because of the fish cultural importance of the Madison River, the presence of furunculosis assumes serious proportions. It is generally believed that furunculosis was brought to the western hemisphere with the brown trout which were introduced into the United States from Germany in 1883. It seems far more likely, however, in consideration of the well known fact that any species of animal tends to develop a high natural immunity to any disease to which it is exposed over a period of years, that furunculosis was originally a disease of the rainbow trout of Western United States. Such an hypothesis would explain the relatively high immunity to furunculosis enjoyed only by the rainbow trout. The sudden appearance of furunculosis in both the United States and Europe followed closely upon the general distribution of the Shasta rainbow in 1880. In this respect, a note by Belding (1928) that furunculosis was observed, although not positively identified as such, in Pennsylvania about 3 years before the disease was described in Europe by Emmerich and Weibel is of interest. However, regardless of the origin of furunculosis, it seems quite certain that fish cultural operations have been primarily responsible for its spread.

Generally speaking, in the United States furunculosis is still regarded as being purely a hatchery disease and of little or no consequence to wild fish. In fact, the general practice when furunculosis appears at a hatchery is to liberate the infected fish as soon as possible to avoid the obvious heavy mortality which inevitably follows if the fish are retained under a confined hatchery environment. This practice is predicated upon the fact that furunculosis has never been reported from most of the waters which have received infected fish. It is probably true that in most instances, the liberation of infected fish from hatcheries has failed to establish the disease among the native inhabitants. However, it is becoming increasingly more apparent that at least under certain circumstances, unknown it is true, this practice has resulted in considerable irreparable damage to the trout and salmon resources. So little is known about furunculosis, as it may exist outside the hatcheries, that few facts are available on which to base a conclusion as to how much actual damage has been, or is being, done to the trout and salmon resources by liberating furunculous hatchery fish. Furunculosis in the United States is a problem of the first magnitude, demanding immediate study and consideration.

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Methods of Measuring Anglers' Catches in Inland Waters[1]

By P. R. NEEDHAM

WITH very few exceptions, the only criteria that fishery officials now have by which to judge the fishing condition of any lake or stream are the praises or complaints of fishermen. If the fishing holds up and continues to be good in any given water, little is usually said about it. However if the fishing becomes poorer or the fish harder to catch then a cry goes up from the anglers and frenzied attempts may be made by planting the lake heavily to bring it back to its former productivity. But the complaints or praises of anglers are seldom based on sufficient evidence to warrant any given type of treatment. When the fishing falls off in any lake, it may merely be that more anglers are fishing it and hence the fish are spread over a larger number of fishermen. The basic productivity of a lake in game fish is not changed unless natural conditions change considerably. This they usually do not do from year to year unless man interferes to upset the natural biological balance for better or for worse. Any given lake will produce only so many pounds of fish per acre of water area. If the take exceeds the supply then naturally the fishing will deteriorate. Our waters should be managed on a sustained yield basis. Catch records can and will furnish the needed basis of facts to measure the trend of fishing.

Biological surveys have conclusively shown, and many anglers realize, that each lake differs individually from most other lakes, that each presents unique management problems. Hence general conservation policies for wide areas should be replaced by specific policies for specific waters, in relation to the individual problems involved. The application of identical conservation measures to widely varying and often large regions, without regard to differing climatic, geographic or biological conditions in each, have in the past proved largely ineffectual.

Stream and lake surveys provide data for at least the preliminary stocking policies needed. One way to check the results is to record anglers' catches by developing a system for securing voluntary returns. Another method is that of taking quantitative collections of fish from gill-nets or seine hauls; but this method usually produces rather incomplete and unsatisfactory results. More accurate methods may be developed, but it is the writer's belief that records of anglers' catches would make available a definite measure of the annual trend of the fishing in both streams and lakes. Putting the licensee in direct contact with conservation agencies would have the added advantage of educating him, and stimulating his interest in conservation matters.

Various states have made sporadic efforts to collect angling statistics in inland waters. Such work has usually been directed toward determining the availibility of fish to fishermen by measuring the catch per unit of effort. Michigan instituted its state-wide creel census in 1927 and has continued this every year on a large scale. California, in 1932, placed in effect a system

[1] Published by permission of the U. S. Commissioner of Fisheries. The catch data herein recorded were obtained as one of the projects of the California Trout Investigations that are being conducted jointly between the U. S. Bureau of Fisheries and the California Division of Fish and Game. This paper is printed under a grant from the American Wildlife Institute, for the publication of contributions fundamental to fish management.

for obtaining statistics relating to marine sport catches in the ocean off Southern California (Clark and Croker, 1933). Clark (1934) pointed out further the desirability of securing sport catch records whether taken in salt or fresh waters, and that any plan adopted should be tested carefully and modified as desirable.

Lord (1935) reported that good catch records were obtained through the use of a so-called "test stream" where all anglers were required by law to report their catches. Eschmeyer (1935) reported that good catch records were also obtained through the use of a CCC census crew to contact anglers for their catch records on Fife Lake in Michigan, and this method has been materially expanded in that state.

Another method used by the writer in connection with lake studies in California has been to secure the cooperation of resort owners in recording catches from lakes on which their resorts are located. Catch records have been secured by this method from Convict Lake and Upper Angora Lake lying at high elevations in the Sierra Nevada Mountains. Each of these lakes has only one resort on its shores, and fishermen are easily contacted since only one road or trail gives access to each lake, and anglers pass within a few steps of the resort entrances. Marked fish of various sizes and species were planted in both lakes to determine, from the catch records obtained, the relative mortality of each plant to anglers' creels. Here only the incomplete results obtained to date with regard to Convict Lake are submitted.

Planting Experiment in Convict Lake

In the summer of 1935, the writer and assistants planted 2,014 rainbow trout averaging 5.67 inches in length in Convict Lake in eastern California. These fish were marked for future recognition by cutting off the adipose and left pelvic fins from each fish. Convict Lake afforded a good opportunity to try out a method of securing boat catch records from which could be determined the catch per unit of effort. Only one camp, the Convict Lake Resort, leases boats on the lake. The operators of this resort, Mr. and Mrs. Wm. Garner, gave every cooperation in securing daily records of the catches. Accordingly the following system was adopted for securing returns both from fishing parties renting boats and from anglers fishing from the shoreline.

For boat catch records, blanks like that shown on the opposite page were filled out completely by anglers upon returning the oars to the resort, at the conclusion of a rental period for any one day. Persons renting boats for more than one day were asked to fill out one blank for each day that fishing was done. One person only filled out one blank for any given party in one boat and usually this was the person who returned the oars.

This blank took care of returns from boat fishing. For returns from shore fishing it was necessary to post large, conspicuous signs at all important camp sites, fishing points, trails, etc., announcing the fact that records were wanted from all trout caught, whether marked or unmarked, and the object of the work. Liberal use of the word "please" was very helpful. It is highly important in work of this kind that no antagonism be aroused. In large letters and underscored at the bottom of the signs a large "PLEASE RECORD YOUR CATCHES AT THE CONVICT LAKE RESORT," appeared. Special blanks for

recording catches made by shore fishermen were placed at the front desk in the Convict Lake Resort. Here they were written in as reported by anglers. Boat catch records are estimated as being 98% complete, but it is doubtful if the shore returns are over 65 to 75% complete. If it were not for the fact that the Convict Lake Resort is located about one-quarter mile below the lake on the only road giving access to the lake and provides the only dining room, store and gasoline pump within about 6 miles, the shore-fishing returns would probably have been even more incomplete than they were. In this connection, it is rapidly becoming evident from the catch record work done to date, that when voluntary returns alone are expected from fishermen without the aid or help of persons especially assigned to follow-up and urge their cooperation in submitting the necessary reports to the authorities concerned, only very incomplete results will be had.

Records of the Catch from Boats

Table 1 gives a summary of all trout caught by boat fishermen in Convict Lake from July 20 to October 31, 1935. Since the experiment was begun July 20, 1935, when the marked fish were planted, no returns were received from May 1, when the season opened, to July 19.

TABLE 1. ANALYSIS OF THE RECORDS OF CATCH FROM BOATS IN CONVICT LAKE, JULY 20 TO OCTOBER 31, 1935

Month	No. of Boat Reports	No. of Anglers	Total Fishing Hours	Fish Taken: Unmarked Brown Trout	Fish Taken: Unmarked Rainbow Trout	Fish Taken: Marked Rainbow Trout	Total Trout	Catch per Unit Effort[a]
July	34	62	270	12	19	4	35	0.13
August	51	99	414	23	45	25	93	0.24
September	10	19	83	0	11	0	11	0.13
October	2	4	29	23	1	4	28	0.96[b]
Total	97[c]	184	796	58	76	33	167	0.21

[a] One hour's fishing by one angler.
[b] Based on two returns made by four expert fishermen.
[c] 106 blanks were returned, but 9 made out for 15 anglers could not be used in calculating catch per unit of effort as they failed to state the number of hours fished.

BOAT CATCH RECORD
Convict Lake—1935

Number of boat: Date:
Number of fishermen: Hours fishing:
Trout caught:

Unmarked	Number	Estimated Weight	Length
Brown or loch leven[1]			
Rainbow or steelhead[1]			
Marked rainbows			

Remarks

(Signed)
Address

[1] Since Loch Leven and brown trout have been thoroughly mixed by fish culturists, all gradations may be found and hence both were recorded in one category on this blank. The same may be said for rainbows and steelheads. No other game fish are found in Convict Lake except rarely a golden trout.

The returns for boat fishing submitted in Table 1 indicated the average catch per unit of effort to be 0.21 trout. In other words, a person fishing during the season of 1935 would have had to fish about 5 hours to catch 1 fish if his fishing ability was average. Evidence that expert fishermen get the bulk of the fish is shown by the fact that only half of the boats rented actually took trout. The average catch per boat of those taking trout was 3.6 fish. The average length of the rental or fishing period was slightly over 4 hours, approximately half a day.

If the catch per unit of effort by boat fishermen be obtained in this lake annually, a very definite measure of the trend of its fishing will be had. It will serve as an accurate measure of results of any management or stocking system put into effect. This is a method that would be applicable to intensively fished inland lakes generally.

Total Returns from Convict Lake in 1935

The following brief summary of all returns received from both shore and boat fishermen in 1935 in Convict Lake should be considered as preliminary, and are given to demonstrate a method rather than for the facts determined.

It is to be noted (Table 2) that a total of 337 anglers caught 848 trout in the lake. Of the latter, 499 or 59% were unmarked fish (25% brown trout; 34% unmarked rainbow trout), and 349 or 41% were marked rainbow from the planting of July 20. Approximately 77% of all fish taken were caught by shore fishermen while 23% were taken from boats.

TABLE 2. TOTAL RETURNS FROM SHORE AND BOAT FISHERMEN IN CONVICT LAKE, JULY 20 TO OCTOBER 31, 1935

Fish caught from	No. of Anglers	Total Trout		Unmarked Brown Trout		Unmarked Rainbow Trout		Marked Rainbow Trout	
		No.	%	No.	%	No.	%	No.	%
Shore	134	650	76.6	138	64.1	199	70.0	313	89.6
Boat	203	198	23.3	77	35.8	85	29.9	36	10.3
Totals	337	848	...	215	...	284	...	349	...

Boat fishermen caught the larger fish and hence the greater poundage even though the actual numbers taken were less than from shore. Marked rainbows formed 48% of shore catches and 18% of boat catches, showing that the smaller fish, as expected, were most abundant in shallow water.

Computation of the Trout Population in Convict Lake

Of the 2,014 marked rainbow trout planted, the 349 reported caught constituted 17.33% of the total plant. The 284 unmarked rainbow trout formed 44.86% and marked rainbows 55.13%, respectively, of the total catch of 633 rainbow trout. By using these figures, it is possible to calculate roughly the total population of rainbow trout present in Convict Lake in 1935 as follows:

Let a = number of marked rainbow planted in lake July 20 (= 2014)
b = number of marked rainbow reported caught after July 20 (= 349)
c = number of unmarked rainbow reported caught after July 20 (= 284)
x = number of unmarked rainbow in lake July 20
y = total rainbow population July 20

On the assumption that the number of marked and unmarked trout reported caught bore the same ratio to the total population of both marked and unmarked fish in the lake, respectively, then:

$$(1) \quad \frac{a}{b} = \frac{x}{c}.$$

By substituting values given above, the number of unmarked rainbow (x) on July 20 can be calculated directly by proportion. The total population of rainbow (y) on July 20 can then be determined simply by addition ($a + x = y$) or directly from the formula:

$$(2) \quad y = (b + c)\frac{a}{b}.$$

If marked fish were planted more than once the computations would be more complicated but still not difficult. From the calculations outlined above, the rainbow trout population of Convict Lake may be summarized:

TABLE 3. THE COMPUTED POPULATION OF RAINBOW TROUT IN CONVICT LAKE

	Population on July 20, 1935		Reported Caught		Remaining at End of Season	
	No.	%	No.	%	No.	%
Planted (Marked) Population	2014	55.13	349	55.13	1655	55.13
Calculated Unmarked Population	1639	44.86	284	44.86	1355	44.86
Total Population	3653	....	633	....	3020	....

The calculations shown in Table 3 can only be considered as extremely rough approximations by reason of the following sources of error:

(1) Incomplete returns. For this reason the computed number of fish remaining at the end of the season is certainly too high because of fish caught but not reported. Records from shore fishermen were more incomplete and harder to obtain than reports from boat fishermen, as noted above. Since marked fish predominated in the shore catches and since unmarked fish were taken more largely by the boat fishermen, complete returns would have raised the number of marked rainbow caught with reference to the number of marked fish planted, and therefore given a lower computed value for the number of unmarked fish present July 20.

(2) Marked fish more easily caught than unmarked fish. This is an assumption based on general experience that young hatchery-raised trout freshly planted are more easily caught than wild trout of the same age. The marked rainbow averaged 5.67 inches in length when planted and fish of this size usually take bait or flies readily. This factor would make for imperfect sampling of unmarked population by fishermen and for this reason the number of unmarked rainbows in the lake was probably higher than computed, both on July 20 and at the end of the fishing season.

(3) Losses of fish due to predators, disease, and cannibalism. There were undoubtedly losses of fish due to these causes and no allowance is made in the calculations in Table 3 for such losses. These factors would lower the population remaining at the end of the season below the computed number. To what degree sources of error (1) and (3) compensate for source of error (2) is not evident.

(4) Lack of proof that in-shore and off-shore populations were representatively sampled by anglers in relation to the actual in-shore and off-shore populations. Since marked trout were taken chiefly near shore and no doubt were more numerous there, any disproportionate sampling of this population would distort the calculated values obtained and give erroneous computations of the population. These sources of error are quite unmeasurable, and today no ready means is apparent for estimating either their magnitude or their direction. Since they may be high, these computations must be regarded as only very rough approximations. Great care must be utilized in the application of these data to management problems.

We are not justified in calculating the brown trout population from the proportion recorded as caught as these fish are much harder to catch than the rainbows, in the opinion of most experienced anglers.

The measurement of trout populations can only be obtained by planting experiments with marked trout in "test lakes," where complete or nearly complete records of the catch are possible. From these experiments such basic facts will be determined as (1) mortality of planted trout of various sizes and, (2) pounds of fish produced per acre of water area, and in relation to such environmental conditions as food and angling intensity.

Measurement of the Catch per Unit of Effort

Although a complete census is needed to determine accurately the trout population of a given lake, and is very desirable for "test lakes," it is not necessary to take complete returns in order to obtain data of value in fish management. The measurement of the catch per unit of effort affords a definite means of determining the trend of the fishing in any intensively fished lake and can be based on an annual random sample of the catch. The sampling should cover, without selection, both parties catching many fish and those catching few or none, to obtain proper balance between returns of expert and inexpert fishermen. Enough records should be obtained every year to be statistically representative. The sampling should be random as regards season and time of day as well as the skill of the fisherman. This will avoid taking records in one year at a time when fishing tends to be better, and in another year at a time when few fish are caught. If the samples obtained are truly random in nature and gathered consistently from year to year by uniform methods and under uniform conditions, they will be truly representative of conditions and give in turn, accurate measures of the trend of the fishing and fish populations from year to year.

Determining the trend of fishing in streams presents greater difficulties, as noted by many workers. Through the use of "test streams," as demonstrated by Lord (1935), it is evident that satisfactory catch records can be obtained when the census is backed by appropriate legislative action. As for lakes, only random samples are necessary to determine the annual trend of the fishing in any given stream or section of stream from the catch per unit of effort. Before any system of recording the catch be placed in operation, it should be decided whether total catches or merely random samples of catches are desired. Total catches are by far the more desirable. Many

types of useful, pertinent data, that will prove of tremendous practical use in the management of specific waters, can be obtained from complete catch records. In addition to being more generally useful, total catch records will also be more costly and harder to obtain. For streams and lakes that have long been sources of discontent and criticism to conservation officials, the factual data furnished by total catch records would in the end more than pay for themselves. Measurement of annual trends by random samples should be sufficient for non-problem types of waters in which the fish are holding their own fairly well. Taking of total records might be termed the "intensive" method for problem waters while partial or random records might be termed the "extensive" method applicable on a wider scale to waters generally. Much useful information will be obtained by the former method that will be applicable to waters at large. Possibly it would be better to take total records or none at all, in view of the wider range of facts obtained and their subsequent wider application.

To facilitate receiving reports from anglers, it might be more satisfactory to furnish licensees with books or pads of blank forms of convenient size upon which could be written the catch records of separate fishing trips to particular streams. These could then be mailed into the administrative office concerned at the conclusion of each fishing trip. One most important point is that the records be written down the same day the catch is made before memory of them has faded. Records of fish caught mean little or nothing if written some weeks or months following the event. Perhaps a few anglers can recall after a long lapse of time exactly what they caught, where and how long it took to catch a good bag of trout, but such individuals are quite scarce. There is no good reason why catch records should be obtained on remote, inaccessible streams and lakes where the fishing is light at present and where no critical problems exist—unless it is desired to know for purposes of comparison how successful the fishing is in such waters.

As Clark (1934) has clearly pointed out, any system for obtaining voluntary catch records must have the full support of the angling public. To obtain their support a constant barrage of publicity by articles, movies, talks to sportsmen's clubs and over the radio, would need be carried on.

Even if the idea is "sold" to the anglers, it is most difficult to get them to record their catches correctly and honestly. Anglers are usually in too much of a hurry or they find it too much trouble to study the blanks provided to learn how to fill them out properly. In Michigan, conservation officers and selected and trained CCC workers have been employed to gather the records and to fill out the blanks. Lord (1935), as noted above, reported very poor returns until anglers were required by law to report their catches on "test"' streams in Vermont. The work on Convict Lake reported here has inaccuracies caused by incomplete returns. It is beginning to appear that if adequate voluntary catch records are to be obtained, they must be taken under the very close supervision of trained workers or by other special means. Voluntary returns obtained without careful and close supervision have been shown to be too inaccurate and insufficient to produce the information they are intended to reveal.

Before concluding, I would like to quote Mr. Aldo Leopold (1933) on what he calls "Kill Ratios" in his *Game Management*. His remarks, though made with respect to game birds and mammals, apply equally well to fishes. He wrote:

> Statistics based on experience are the only available means of arriving at the proportion of the game population which may be safely killed on any given area without reducing the breeding stock or the size of subsequent crops. The subsequent crops are the best measure of whether the breeding stock has been unduly reduced. Consequently statistics must cover a defined area for a period of years, . . . if a kill-ratio is to be correctly determined. No single case is as yet known in which such a ratio has been derived in this country. There is in this fact a certain irony which should not escape notice. For decades our game literature was largely a record of kills. If there exists, in all these tons of bloody paper, a single accurate bag count applying to a specified population or area through a period of years, then I have failed to find it. Yet these same men, every day of their lives, measured the yield of their fields, their herds, and their commerce in terms of principal and interest.

In summary, adequate records of the catch of inland game fishes would:

(A) Give a definite measure of the trend of the fishing in any lake or stream from year to year following any system of stocking, management, or legal restrictive measures placed in effect.

(B) Produce a daily creel census telling how, when, and where fish are taken, who takes them, and the amount of fishing effort required to catch them from year to year.

(C) Produce basic facts relating to species, size, growth, and pounds of fish caught annually in selected waters.

(D) Point out the need for better balanced and more suitable restrictive measures.

(E) Interest sportsmen in conservation matters generally, and in conserving our fishery resources specifically.

(F) Form a direct contact between the licensee and the county, state, or federal fisheries officials concerned.

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Oral Gestation in the Marine Catfish, *Galeichthys felis*[1]

By Genevieve Lee

FOR four consecutive summers, 1928, 1929, 1930 and 1931, students of the Louisiana State University Summer Field Biology Laboratory at Grand Isle, Louisiana, studied the breeding habits of the six-whiskered marine catfish, *Galeichthys felis*. In 1928, as records were made of the occurrence of this fish in the trawl hauls, it was noticed that *Galeichthys felis* is a mouth-breeder. In 1929, Elizabeth Foster began a study of the breeding habits of this fish. The following summer Rose Beeson continued the work; and in 1931, I made further observations and have now organized the mass of data collected during the three summers. I wish here to make acknowledgment of the work done by Misses Foster and Beeson and to thank them for their generosity in permitting their observations to be used as a basis for further study of *Galeichthys felis*. To Doctor Samuel F. Hildebrand of the United States Bureau of Fisheries, also, I wish to express the appreciation of the laboratory for the courtesy he has extended to us. In August, 1930, he made some observations which proved beyond reasonable doubt that *Galeichthys felis* is a mouth-breeder. Upon learning of the study being made with the same catfish in this laboratory, he kindly transferred his notes to us. I also wish to thank Doctor Hildebrand for reading this paper and offering valuable suggestions for its improvement. Especially to Doctor Ellinor H. Behre, Director of the Laboratory at Grand Isle, do I wish to express my appreciation of her help and encouragement in this work.

An abstract of this paper was published several years ago (Lee, 1931).

Most of the material of *Galeichthys felis* used in this investigation was obtained by trawling in the bays and Gulf around Grand Isle, but some was gotten by seining and some by fishing with hook and line. Upon bringing up the trawl, the mouths of males carrying eggs or young were wrapped in cheesecloth and tied to prevent the fish from spitting out the offspring. Due to the confusion in the net and rough handling as it is brought into the boat, the catfish quite often throw out their eggs. However, if the net is brought up very carefully and the fish are not shaken out but removed by hand, few eggs are lost. When the fish are handled as described, and their mouths are full, the egg count per male is considered accurate.

The desired measurements and dissections, if not made between trawl hauls, were made in the laboratory very soon after arrival from the trawling trip. Each catch was wrapped separately in cheesecloth to prevent mixing. Only fresh specimens were used for measurements. The fish being brought in were kept in closed containers to prevent drying. Upon arrival at the laboratory, the eggs were taken from the mouths of the males, counted and sometimes measured. Attempts were made to keep eggs alive by means described on a succeeding page.

Habitat and Abundance

The two species of Ariidae that are found in the bays and Gulf around Grand Isle are *Galeichthys felis*, the silver cat or sea cat, and formerly known

[1] Contribution from the Louisiana State University Summer Field Biology Laboratory at Grand Isle, Louisiana.

as *Hexanematichthys felis, Galeichthys milberti,* etc., and *Bagre marinus,* the gaff-topsail, formerly named *Felichthys* or *Ailurichthys felis* (the nomenclature of these species is discussed by Hubbs, 1936: 178–179). During the time that we collected, the silver cat is by far the more abundant, and both are more numerous in the bays and inlets than in the Gulf. The silver cat is quite often the dominant form in hauls from the bays, but in hauls of the trawl in the Gulf it frequently is missing altogether.

In 1931, many tiny gaff-topsails (*Bagre marinus*) were taken in one haul and very small ones occurred in another. Aside from these catches, scarcely a half dozen of this species were caught in trawls, seines or on hook and line during the summer of 1931; numerous trawl hauls were made without finding a single one. The records of 1930 show that this fish was more plentiful that year; those of 1929 show the species still more numerous; in 1928 gaff-topsails were obtained on practically every trip. No reason is known for this change in abundance.

In the vicinity of Grand Isle, *Galeichthys felis* has been found in water from 2 to 90 feet deep on muddy or sandy bottoms. Mud, or mud and sand, seem to be preferred to sand or shell bottoms, and shallow water to deep water. In many places, the silver cats are so plentiful that numbers of them will rise to the surface of the water after bread crusts, orange peel, etc. When fished for with hook and line, almost anywhere in the bays, sea cats are landed one after another, on almost any kind of bait.

No spawning females of *Galeichthys felis,* or males carrying eggs, have ever been obtained in the trawl hauls in the Gulf, but only in hauls from the bays and inlets, during the four summers when this study was made. It seems, therefore, that in the vicinity of Grand Isle spawning takes place only in the bays and inlets, and not the Gulf. However, the trawl touched bottom in inside waters where breeding was found and I cannot prove that it did so in Gulf waters.

Breeding Season

In arriving at conclusions as to the duration of the breeding season of *Galeichthys felis,* I have used as criteria: (1) the abundance and degree of development of the eggs when collected from the mouths of the males, and (2) the conditions of the ovaries of the females taken at the same time.

Observations were made only during the following periods:

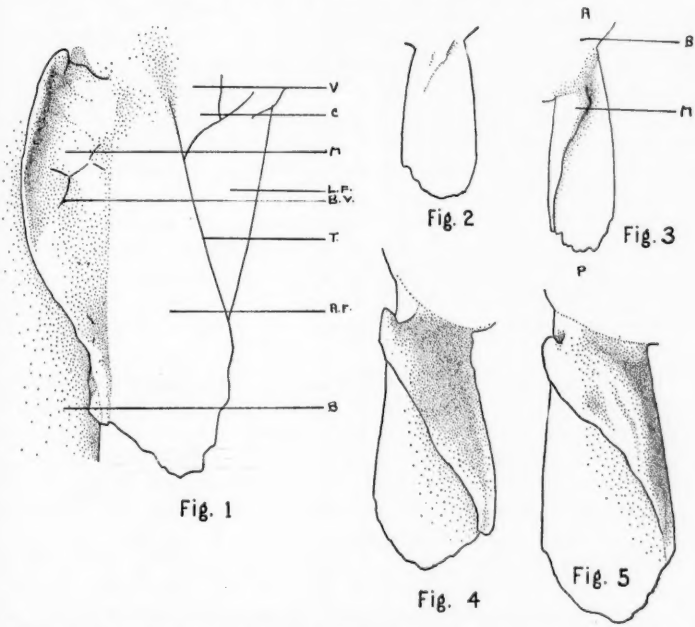
1928: June 18 to July 26. Eggs obtained from June 18 to July 21, inclusive.
1929: June 15 to July 17. Eggs obtained from June 22 to July 17.
1930: June 15 to August 2. Eggs obtained from June 20 to July 26.
1931: June 16 to August 8. Eggs obtained from June 20 to August 5.

From a detailed record of all hauls of 1931, with particular reference to more than 60 males of *Galeichthys felis* that were carrying eggs or young, the following facts are apparent:

1. Earliest date when eggs were obtained, June 20.
2. Earliest date when young were obtained, July 12.
3. Last date when eggs in early stages of development were secured, July 12.
4. An increasing number of eggs ready to hatch, and young fish, were secured from July 12 to August 5.

5. Fish with spent ovaries and ovaries in a gravid condition, with increasing number of gravid ones, taken until July 12.
6. Two ripe females caught on July 12.
7. First spent females caught on July 9.
8. An increasing number of spent females taken from July 12 until August 5.
9. A gradual increase after July 12 in the number of females with undeveloped ovaries.
10. An increase after July 12 in the number of females with ovaries showing that spawning had not taken place recently.

From these facts it is concluded that the breeding season begins at the latest early in June and lasts until about the middle of July.



Figs. 1–5. Modification of the dorsal surface of the pelvic fin in the females of *Galeichthys felis.*

Fig. 1. Right pelvic fin of a spawning female, in natural position. The dorsal surface of the fin has been forced into a lateral (sagittal) position by the modification.

Fig. 2. Right pelvic fin of a gestating male.

Fig. 3. Right pelvic fin of an immature female, showing an early stage of the modification, in natural and original position.

Fig. 4. Left pelvic fin of a spawning female, showing the tremendous development of the modification, which has been forced back into its original position.

Fig. 5. Left pelvic fin of a spent female, showing the degeneration of the modification, in natural position.

A, anterior; *B*, body of fish; *B. V.*, blood vessel; *C*, cut edge of body; *L. F.*, left pelvic fin; *M*, modification; *P*, posterior; *T*, trough formed between the pelvic fins; *V*, ventral surface of fish.

Modification of the Pelvic Fin in Females

Associated with the breeding season of *Galeichthys felis* is the development of a peculiar modification of the pelvic fin (Figs. 1–5), in the adult females only. This fact was first noticed by Elizabeth Foster in 1929. The

modification consists of a right-triangular flap-like growth of tissue supported by a cartilaginous ray. The long side of this right triangle extends along and grows from the dorsal, inner, margin of each pelvic fin. The short side of the triangle extends out from the anterior portion of the fin and forms a free protuberance. The hypotenuse of the triangle is free. At the junction of the hypotenuse and short side is the protuberance.

No such modification of the pelvic fin has been found in the male, although in egg-carrying males the fin shows a white, almost ridge-like area (Fig. 2), corresponding in position to the modification in gravid females. The significance of the ridge, if indeed it has any, is not understood; it is perhaps only a rudiment of a structure proper to the other sex.

Rose Beeson (unpublished notes, 1930) found that as the ovary develops to maturity, the pelvic fin modification of the females becomes larger; and when the ovary becomes spent, the modification degenerates. My observations agree perfectly with hers on this point. The pelvic fin is little modified in females with ovaries in an early stage of development (Fig. 3). As the ovaries mature, these fin modifications grow very large, becoming thicker and more vascular, until in the ripe fish they reach the condition shown in Figs. 1 and 4. Here, the modifications have developed to such an extent that they stand out from the fins, causing the pair of fins to form the sides of a trough. To accomplish this, the lateral margins of the fins are forced into an almost ventral position, so that the dorsal surfaces of the fins are the outside of this trough and the ventral surfaces the inside. The modification degenerates in spent females (Fig. 5).

The smallest female found possessing a fin modification was only 126 mm. in standard length, but it was gravid (its left and right ovaries measured respectively 50×18 and 43×16 mm.). A plausible explanation for the existence of this modification is that it is an adaptation causing the fins to form a trough, the use of which can now only be conjectured. Perhaps as the eggs are extruded, they are held momentarily in the trough, where they are fertilized and then taken into the male's mouth.

Since this peculiar modification of the pelvic fin in the mature female of *Galeichthys* was discovered by us (Lee, 1931), it has been further discussed by Breder (1935: 162). Hardenberg (1935: 55, 2 figs.) has described and figured a similar modification in the mouth-breeding East Indian species *Arius maculatus*, and has hypothecated the use of the structure as a clasping organ, of significance in the fertilization of the eggs. As mentioned by Breder, Hubbs has found that *"Conorhynchus" nelsoni* of the Rio Usumacinta system of Mexico and Guatemala, really an ariid rather than a pimelodid catfish, and known to practice oral gestation (Evermann and Goldsborough, 1902: 140–146, fig. 1), also develops a similar modification of the pelvic fin in mature females. In all probability this modification is wide-spread through the family, though not of universal occurrence, for Gudger failed to note the structure in *Bagre marinus* and Hubbs found it undeveloped in *Arius aguadulce* (as reported by Breder).

Perhaps as a further adaptation to insure the fertilization or safe transfer of the eggs, the pelvic fins of the mature females of *Galeichthys felis* are much

larger, in proportion to the length of the fish, than in the males (Table 1 and Fig. 6). After this difference was noticed, measurements were made of the length of the body and of the left pelvic fin of 100 males with and without eggs and of 100 immature, spent and gravid females. The body length was taken laterally from tip of snout to base of caudal fin. The pelvic fin was measured along its outside margin from base to farthest tip. No measurements were made of specimens less than 150 mm. long, because these smaller specimens generally show no great sexual difference in length of pelvic fin.

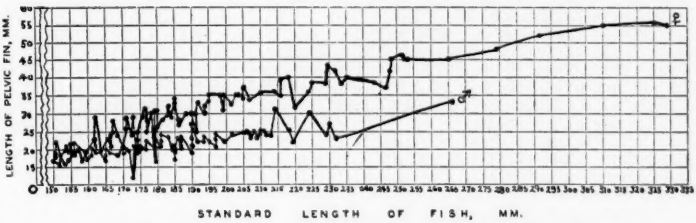


Fig. 6. Relative length of pelvic fin in males and females of *Galeichthys felis*.

With increased size, the sexual difference in the proportionate size of pelvic fins is increased. For this reason, and because the females reach a larger size, the absolute size of the pelvic fin in mature fish is typically much greater in females than in males.

TABLE 1. SEXUAL VARIATION IN LENGTH OF PELVIC FIN IN *GALEICHTHYS FELIS*

	Standard length	Length of pelvic fin	
		in mm.	In thousandths of standard length
Males	183.2 mm.	21.2	116
Females	196.2 mm.	31.1	159

In *"Conorhynchus" nelsoni* also, the modification of the pelvic fin in the female is associated with an enlargement of the pelvic in that sex (Hubbs, MS).

Oral Gestation by the Males

Another important feature associated with the breeding habits of *Galeichthys felis* as of many other ariid catfishes is the fact that the male fish carry the eggs and young in their mouths, until the young are able to care for themselves. Oral gestation has been indicated for this species by Smith (1907: 63), whose statement that the eggs are deposited in a sandy depression, before being taken into the mouth, needs confirmation.

In writing of *Bagre marinus* Gudger (1916, 1918) showed that the hyoid region in the males becomes depressed, as the breeding season approaches, to make room for the eggs. The same change was watched for in *Galeichthys felis*, but only males carrying eggs or young were found to possess this enlarged oval cavity (Figs. 9 and 10). The hyoid region of males with no eggs is not so modified (Figs. 7 and 8).

Males carrying eggs in 1931 ranged in standard length from 142 to 232

mm. The largest number of eggs or young found in the mouth of any one male, in 1931, was 40; these were young averaging 40 mm. in length and were taken from a male 266 mm. long. Rose Beeson, in 1930, found one male carrying 33 young already hatched; the greatest number of eggs that Miss Foster observed in 1929 was 38. In 1929, 48 eggs were found in the mouth of one male—a record for the entire investigation.

As would be expected, the eggs in a fish's mouth, with few exceptions, were in the same stage of development. Sometimes one or two unfertilized eggs were found and on July 18, a catfish was examined holding 14 eggs in a late stage of development and 1 egg in an intermediate stage (perhaps as the result of retarded development).

In the egg-carrying males, all of which were examined in this regard, the testes were much more developed than in non-carriers. In the latter, the gonads generally were very string-like in appearance, sometimes measuring only 1 mm. in width, whereas those of egg-carriers were at least 1.5 mm. and usually 2 to 4 mm. wide.

Feeding Habits Related to Reproduction

Rose Beeson never found any definite trace of food in the stomach of egg-carrying *Galeichthys*. Quite often, however, an unidentified green substance was present in the stomachs of these fish. In 1931, out of 46 egg-carriers, whose stomachs were examined, 23 were found with empty stomachs, 14 with the dark greenish substance, 8 with white or yellow secretions, and 1 with green algae. Eggs have often been found in the stomachs of these males, but as none of these eggs have shown signs of digestion and as all were in the same stage of development as those in the mouth, the conclusion has been reached that these eggs were swallowed for the same reason that they are usually spit out, namely, because of the confusion resulting when the fish are brought up in the trawl. In their natural habitat, the males, when attacked, possibly make an effort to save their offspring by spitting them out.

That the females eat their eggs has been thought to be quite probable. Rose Beeson (unpublished data) states that in 1929 a "female was found with 2 eggs in the stomach, one showing disintegration due to digestive processes." Four females were found in 1930 each with 1 egg in its stomach. In 1931, a female with 1 egg and another with 2 eggs in the stomach were noticed.

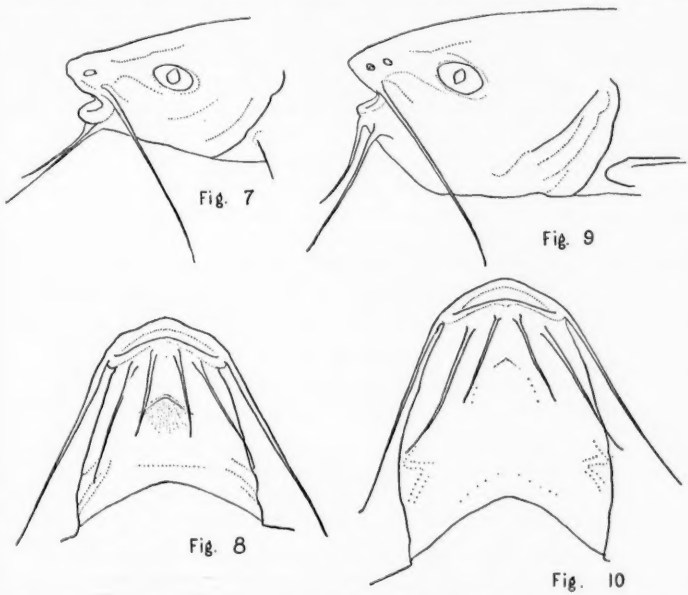
Although these observations do not show that eggs of its own species are a common article of diet for *Galeichthys felis*, yet the males, possibly, and the females, undoubtedly, do at times eat their eggs.

The habit of egg-eating may well be the basis for the belief that *Galeichthys felis* is ovoviviparous (Evermann and Bean, 1897: 240). As indicated by Breder (1935: 162–164), the same habit may explain the reputed gastric gestation of a South American ariid, *Tachysurus barbus*, though Devincenzi (1933) presents some anatomical evidence favoring his theory.

Attempts to Keep Eggs Alive in the Laboratory

Of several attempts made to keep eggs alive in the laboratory, some were successful in a measure and others failed completely.

When obtained on a trawling trip, the eggs were brought to the laboratory either in the mouth of the fish or in a jar of sea-water. Those left in their natural habitat for this journey seemed to survive longer. Upon being transferred from the mouth of the fish to sea-water held in an evaporating dish, many eggs died within a few hours. However, if the sea-water was changed



Figs. 7 to 10. Heads of non-gestating and gestating males of *Galeichthys felis*, showing the modifications for oral gestation.

Figs. 7 and 8 show the head in lateral and ventral view of a non-gestating male 168 mm. in standard length.

Figs. 9 and 10 show the head in lateral and ventral view of a male 172 mm. long, that was gestating 12 eggs.

after these early deaths and only a few eggs were left in the evaporating dish, the chances of survival for several days were favorable. Small fish just hatched and eggs ready to hatch had a higher mortality than other stages. When large embryos were helped out of the egg membrane, the fish lived for only a short time. A few hours after some eggs almost ready to hatch had been placed in fresh sea-water, several young were found half-way out of the egg-case, but all were dead.

Once, 5 eggs with embryos almost ready to coil were kept alive for 3 days in a finger bowl, with a change of sea-water 3 times a day. Of another batch consisting of 6 eggs in approximately the same stage of development, 5 were kept alive for 6½ days and one for 8½ days in a finger bowl, with a change of water twice daily.

In an attempt to grow the young fish of a brood, 2 young were kept alive for 11 days, by which time each had grown from 40 mm. to 45 mm. in length.

Five individuals of another brood, kept alive in the same aquarium for the same length of time, grew from 29 mm. to 34 mm. When first obtained, the smaller fish could not swim, owing to the cumbersomeness of their yolks, but slid along on the bottom of the dish. At the end of 11 days, the yolk had diminished to such an extent that they could swim quite creditably.

Summary

Galeichthys felis prefers shallow water with a muddy bottom as a habitat, and probably spawns in the bays and inlets of Louisiana rather than in the Gulf. The breeding season in the vicinity of Grand Isle, Louisiana, lasts a little over a month, from approximately the early part of June until the middle of July. This fish like other ariids is a mouth-breeder, the males gestating the eggs and young fish. In the females the pelvic fins are enlarged and become highly modified to form a trough, in response to the development of a hard triangular flap on each fin. This modification develops as the ovaries mature, and reaches its maximum development at the height of the breeding season, degenerating thereafter. Egg-carrying males eat little or nothing; at times the females certainly eat their eggs.

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Ichthyological Notes

NOTES ON THE SPAWNING OF THE PACIFIC HERRING, *CLUPEA PALLASII*.—The Pacific herring spawns in Puget Sound in the early spring from the middle of February on. On March 20, 1936, the author had an opportunity to observe the spawning in Holmes Harbor on Whidby Island. This is a long, narrow bay, in the inner end of which grow many acres of eel grass on which the herring deposit their ova.

Several large schools of herring were observed in the bay during the morning. At 11:30 A.M., an hour and 15 minutes after high water, one of these schools approached the shore and commenced spawning in the eel grass. At this time the water temperature was 8.1° C. at the surface. Spawning continued until 1:40 P.M., when the herring left suddenly. Within 10 minutes after spawning began, the water over several acres became milky and opaque from the milt. Spawning took place from the very edge of the water out to where the depth was 15 or 20 feet. The fish were easily approachable with a skiff, and the spawning act was readily observed in the shallow water.

In depositing the ova, the female turns on her side and, with the fins fully extended and the body held nearly rigid, moves slowly forward with small, rapid undulations of the body. The vent is thus brushed over the upstanding strands of eel grass. During the spawning act, the body is arched sharply backward, causing the vent to protrude slightly. In the sexually mature female, the posterior edge of the vent is developed into a fleshy lobe. As the herring bends back, this lobe is protruded outward and forward, partially closing the vent and preventing the escape of the ova. When the vent is dragged forward over a strand of grass, or other object, this flap is pushed open allowing the escape of several ova, which immediately adhere to the grass. Any pressure on this lobe from behind closes it more firmly. This mechanism thus allows the ova to escape only when the vent is moved forward in contact with some object, thus insuring their deposition above the bottom.

The male herring spawns in a manner similar to the female, holding the body and fins in the same positions, and moving forward over the grass in the same manner. The structure of the vent described above is also characteristic of the males. In this sex, a very slight pressure just anterior to the vent is sufficient to cause the emission of a few drops of milt.

The herring remains on its side 2 to 5 seconds. Thereafter, it rights itself and rests for several seconds, after which the spawning act is repeated. No pairing of male and female fish was observed. Rounsefell (Bull. U. S. Bur. Fish., 45, 1929 (1930): 277), in describing the spawning of herring in Kachemak Bay, Alaska, wrote: "In spawning, the female, quivering from head to tail, turns on her side and moves slowly about. . . . In like manner the male follows a few inches behind the female, covering the attached eggs with a stream of milt." We did not observe any such pairing, except as a male might, occasionally, fortuitously follow a female for a short distance. Seemingly, this is mass spawning. The effective impregnation of the eggs thus depends upon a relatively large number of individuals spawning together.

When herring from the wiers in Holmes Harbor were examined, it was found that the sample included females in all stages: spawned out, partially spawned out and unspawned. This seems to indicate that all the ova are not spawned at once, but that several days are required for spawning to be completed.—MILNER B SCHAEFER, *Washington State Department of Fisheries, Seattle, Washington.*

A NEW NAME, *SEBASTICHTHYS HUBBSI* MATSUBARA, SUBSTITUTED FOR *SEBASTICHTHYS BREVISPINIS* MATSUBARA, FROM JAPAN.—In 1936, I proposed a new name, *Sebastichthys brevispinis* (Jour. Imp. Fish. Inst., 31 (2): 84), as a substitute for *Sebastichthys elegans* of Jordan and Starks. Dr. Carl L. Hubbs has kindly informed me that the specific name *brevispinis* has been used for an Alaskan species of the same genus. I, therefore, replace the name *Sebastichthys brevispinis* Matsubara with the new specific name *Sebastichthys* ***hubbsi***, in honor of Dr. Carl L. Hubbs. It is my pleasant duty to return herewith my hearty thanks to him for kindness extended to me.—KIYOMATSU MATSUBARA, ZOOLOGICAL LABORATORY, IMPERIAL FISHERIES INSTITUTE, TOKYO, JAPAN.

ON *CARANX HIPPOS* (LINNAEUS) FROM ECUADOR.—Among carangin fishes which Mr. William J. Morden arranged to have sent to the American Museum of Natural History on his recent trip to South America, there is a series of 10 specimens of *Caranx hippos,* 110 to 139 mm. in standard length, from the Ecuadorian coast (collected by Mr. F. L. Yoder).

The lesser depth and smaller eye which distinguish larger specimens of *C. hippos* from *C. ignobilis* are not appreciable at this size, but color places them definitely with the former. They have a sharp black spot on the upper corner of the gill-cover, and 5 of the 10 have an area of scattered dark specks on the basal lobe of the pectoral, presumably indicative of the spot characteristic of *hippos* at larger sizes. In Atlantic *C. hippos* material to hand, the larger specimens (over 145 mm.) have this spot and the smaller (110 mm. and less) lack it.

In these Ecuadorian specimens the scutes become very small anteriorly and do not reach the front end of the straight part of the lateral line—a condition which is characteristic of *C. hippos.* The scutes are more numerous, and the straight part of the lateral line is slightly longer, relatively, than in either *C. ignobilis* or Atlantic *C. hippos.* The gill-rakers, averaging as in *C. ignobilis,* are slightly more numerous than in Atlantic *C. hippos:* there are 15 or 16 on the lower limb of the arch (average 15.7), as compared with 14 to 17 in 11 specimens of *C. ignobilis* (average 15.4), 13 to 16 in 23 specimens of Atlantic *C. hippos* (average 14.0).

Their depth (in standard length) is 2.5 to 2.6 (average 2.53); eye (in head) 4 to 4.5 (average 4.13); scutes 32 to 38 (average 35.5); curve of lateral line in straight part 1.2 to 1.4 (average 1.26).

These characters vary with size, but are fairly comparable in 4 specimens of Atlantic *C. hippos* of 109 to 145 mm., which have depth 2.3 to 2.6 (average 2.4); eye 3.8 to 4 (average 3.95); scutes 28 to 32 (average 29.75); curve of lateral line in straight part 1.1 to 1.2 (average 1.15). This is true also in 4 specimens of *C. ignobilis* of 100 to 142 mm., which have depth 2.3 to 2.5 (average 2.4); eye 3.6 to 4.2 (average 3.92); scutes 29 to 33 (average 31.75); curve of lateral line in straight part 1.2 to 1.3 (average 1.22).

When received from Ecuador their general color, well preserved, was grayish above; dark on top of peduncle; silvery white below. The upper sides faintly showed about 5 broad, dark cross bands, separated by narrow paler interspaces. The soft dorsal was edged with dusky, and there were usually traces of a dusky edging in the angle of the caudal. The bands were broader than they usually are, when present, in Atlantic *C. hippos.*

Though referable to *C. hippos,* this fish is more like *C. ignobilis,* at least in the average number of gill-rakers, and is possibly intermediate in other respects, but has more scutes than either (my highest count is 33 in 12 specimens of *C. ignobilis* of all sizes, and 35 in 23 specimens of Atlantic *C. hippos* of all sizes).

Presumably *Caranx hippos* resembles these Ecuadorian fish throughout its West Coast range. Nichols (1920)[1] wrote of a 280 mm. specimen from the Gulf of California: "as many as 40 scutes may be counted in the straight part of the lateral line, the chord of the curve being contained 1.4 times in the straight part." Meek and Hildebrand, in their *Fishes of Panama* (1925)[2] gave the scute count for Atlantic and Pacific specimens as about 25 to 40, and wrote that Pacific specimens have on the average a slightly larger number of gill-rakers. Small specimens examined from the Galapagos Islands seem to be this form rather than *C. ignobilis,* and they indicate that its change of depth with size is less rapid and continuous than in Atlantic *C. hippos.* In further study of the closely related allied forms it will probably be most advantageous to consider it subspecifically distinct. Günther's name *Caranx caninus*[3] seems to be available for it, as I concur with Meek and Hildebrand *(l. c.)* in referring that form to *Caranx hippos,* assuming that the smaller anterior scutes were not counted, and that the patch of scales on breast and the pectoral spot were overlooked.

Caranx hippos caninus varies from *C. h. hippos* in an opposite direction from *C. h. tropicus*[4] (specimens from Brazil and West Africa). There are specimens of typical *hippos*

[1] Copeia, 83: 44.
[2] Field Museum Pub., Biol., 15 (2): 350–351.
[3] Trans. Zool. Soc., London, 6, 1869: 432 (Panama).
[4] Nichols, *l. c.,* p. 45; poorly described; difficult proportional lateral line measurements not standard; the relative length of the straight part tends to decrease not increase at larger sizes.

to hand from New York to Guatemala. The following analysis will place a large majority of specimens of over 100 mm.

Scutes 27 or fewer; profile slanting in large individuals.....*C. h. tropicus*
Scutes 27 to 33; gill-rakers (not counting rudiments) 13 to 15, profile always rounded.....*C. h. hippos*
Scutes 33 to 40, gill-rakers 15 or 16.....*C. h. caninus*

J. T. NICHOLS, *American Museum of Natural History, New York City.*

NEW RECORDS OF ONTARIO FISHES.—It has only recently been established that the smelt (*Osmerus mordax*) is native to the region about Pembroke, on the Ottawa River, Ontario. Specimens from Muskrat Lake in that vicinity have been received in the Royal Ontario Museum of Zoology and reports which we consider authentic state that it also occurs in Doré Lake in the same vicinity. That smelt are native to these lakes is indicated by the fact that they have been found in them as long as any of the present residents can remember and by stories to the effect that the Indians used to visit the lakes in question at certain seasons for the purpose of obtaining the smelt. Their occurrence in these waters is undoubtedly a relic of the time, following the retreat of the last ice sheet, when an arm of the sea extended up the Ottawa valley to the head of Lake Timiskaming. According to Coleman[1] marine beaches have been found at an altitude of 690 feet above sea level at Kingsmere near Ottawa. The present level of the lake in which smelt occurs is about 3000 feet. Smelt are also said to be native to Green Lake (altitude 476 feet) in the Kazubazua region north of the Ottawa River in the Province of Quebec. In his Check List of the Fishes of the Dominion of Canada and Newfoundland (1913) Halkett recorded the species from Lac-des-Isles, Gatineau district, 60 miles north of Ottawa.

To this same Postglacial marine invasion is probably attributable the annual run of shad (*Alosa sapidissima*) to the Ottawa River. Rev. Ewen J. Macdonald of Alexandria, Ontario, has sent me the skin of a specimen 20 inches long, taken June 6, 1936, in the Ottawa River below the dam at Point Fortune. This date is said to be about 2 weeks later than the usual run which has been coming up to this point "about the time of the cherry blossoms for over one hundred years" and undoubtedly much longer. Among the three or four hundred fish caught by dip nets on the night of June 5–6 none were seen less than 12 inches long and some were larger than the one sent to the Royal Ontario Museum of Zoology. It is not known whether the shad surmount the dam and ascend the Ottawa above Point Fortune but Rev. Mr. Macdonald considers that this may have been possible this year on account of the high water.

Hiodon tergisus was taken by Prof. W. J. K. Harkness in Moose River near the mouth of the Abitibi on August 24, 1931.

Exoglossum maxillingua was this year recorded for the first time from Ontario waters when specimens were taken about July 13, 1936, in the St. Lawrence River near Ivy Lea by Wm. A. Trickey. These fish are locally called "eye-pickers" because of the very general belief in that area that they destroy the eyes of minnows with which they are confined in live bait pails.

FISHES FROM JAMES BAY

Through the kindness of Mr. Lloyd Melville, small collections of fishes were made in 1933 and 1934 in James Bay by Mr. E. S. Pentland for the Museum of Zoology, University of Michigan, and the Royal Ontario Museum of Zoology, Toronto. Following are some of the more interesting records from these collections:

Catostomus catostomus.—East Point and East Main River, also Moose River, 1 mile above Moosonee.

Catostomus commersonnii.—East Main River and Moose River, 1 mile above Moosonee.

Esox lucius.—Moose River 1 mile above Moosonee.

Stizostedion vitreum.—East Main River.

Perca flavescens.—East Main River.

Gasterosteus aculeatus.—East Point, and small tidal creek flowing into Hannah Bay.

Eucalia inconstans.—Freshwater pool on Point Comfort.

Pungitius pungitius.—Small pond at Boatswain Bay.

Rhinichthys cataractae.—Nettitichi Point.

J. R. DYMOND, *Royal Ontario Museum of Zoology, Toronto, Ontario.*

[1] Glacial and Postglacial Lakes in Ontario. Univ. Toronto Stud. (Biol. Ser.) 21, Pub. Ont. Fish. Res. Lab., 10, 1922.

A WHALE SHARK SPEARED ON THE BOW OF A STEAMER IN THE CARIBBEAN SEA.—In July, 1913, at Miami, Florida, I began my study of the whale shark, *Rhineodon typus,* by being shown the skin of a 38-foot specimen. Since then as data (especially photographs) have come to me from all over the oceans, I have made faunal records from various widely separated regions. I have been particularly interested in recording the occurrence of *Rhineodon* in the Straits of Florida and in adjacent regions. The number recorded by myself and others (5 from Havana, 5 from Florida, and 1 from Bimini, Bahamas) taken in connection with the small sizes of some (2 of 6 and 18 feet) have led me to believe that this great fish is found and breeds in the Caribbean–Gulf region.

For years I sought for evidence to substantiate this belief. Mostly the evidence was indirect, but for the Caribbean it had been cumulative and it had about convinced me that the fish had been seen in this sea. The interested reader will find this evidence set out fully in my article on The Geographical Distribution of the Whale Shark, *Rhineodon typus.*[1] And now at long last, comes evidence that definitely settles the question.

In the *New York Herald-Tribune* of April 26, 1934, there was an account of a whale shark struck by the Grace liner *Santa Lucia* in the run across the southern Caribbean from Bristobal (Colon, Canal Zone) to Cartagena, Colombia. The *Herald-Tribune* account spoke of the fish as the spotted whale shark. I at once got in touch with the Grace Line offices and Mr. Cameron Forbes, the director of publicity, sent me the report of Chief Officer A. E. Richards to Capt. Walter N. Prengel concerning the incident. Later when Mr. Richards was in New York for a few days, he did me the courtesy to come to my office in the American Museum and talk the matter over with me. My best thanks are due him for the facts herein set out.

About 7:30 P.M. April 25, 1934, when Mr. Richards was in charge of the bridge, a slight shock was felt. This was attributed to a blow resulting from the driving forward of the ship at 18½ knots into a head sea. In a few minutes, however, the lookout came to the bridge and reported that there was a whale athwart the ship's bow. The captain and the second and third officers were notified. The captain was detained but he sent the others forward and after seeing the huge animal they too concluded that it was a whale. Later, when two cluster lights had been rigged and hung over the bows, practically all the passengers went forward to see the body, and because of its great size everybody thought that it was a whale.

When relieved, Mr. Richards left the bridge and went forward and there he first of all noticed that, instead of a mammal-like horizontal tail with equal lobes, this animal had a fish's vertical tail fin with unequal lobes, and that it had gills behind the head. He next noted the rectangular pattern on the flanks consisting of white spots on a dark gray, almost black background. So he decided that it was not a whale but a whale shark. and the other officers then agreed with him. When shown a photograph of *Rhineodon,* Mr. Richards affirmed that this represented just what he saw. An attempt was made to photograph the fish on the vessel's bow, but the lights were not strong enough. This failure to get a photograph is most regrettable.

The shark was caught by the stem of the vessel behind the gills. About 10 feet of the head end projected on the starboard and about 30 feet of body and tail on the port side. The fish was partly turned so that the side of the head and the flank could be seen as the vessel rose on the swells. The head was under water most of the time, but the rest of the body came to the surface every time the bow rose. The fish was struck about 7:30 P.M. and shortly after 8 P.M. it seemed to be still alive, for it lashed the ship's side with its tail as the ship rose and fell. It seemed to be trying to free itself. Finally it twisted until its back was against the stem. Held thus it was pushed along throughout the night, reducing the ship's speed by 2½ revolutions of the screw. Between 4 and 4:30 A.M., April 26, it was cut in two by the pressure against the cutwater and fell away.

It will interest the reader to know that this is the seventh recorded case of a whale shark impaled on the bow of a steamer—1 near Colombo, Ceylon; 2 in the Red Sea; 3 in the Atlantic; and 1 in the Pacific Ocean. Later I plan to bring all these accounts and their figures together into an article with an appropriate title.—E. W. GUDGER, *American Museum of Natural History, New York City.*

[1] Proc. Zool. Soc. London, 1934 (1935): 879.

A RECORD OF *CENTROLOPHUS NIGER* (GMELIN) FROM THE WESTERN ATLANTIC.—A specimen of the black ruffe, *Centrolophus niger*, the third to be recorded from the western Atlantic, was caught September 12, 1936, on the northern edge of Georges Bank (Lat. 42° 10′ N., Long. 66° 45′ W.) in 130 fathoms. The fish, brought in by Mr. Leo Dupé of the trawler *Thomas Whalen*, was presented to the Museum of Comparative Zoology by Mr. John R. Webster. Other American records of this species, omitted by Bigelow and Welsh (1925) and by Bigelow and Schroeder (1936), are of a 9 inch fish taken at Dennis in 1888 and a 12¾ inch one from North Truro, Massachusetts, collected in 1890.

This species is found chiefly in the Mediterranean although it does not appear to be plentiful there, and occasionally has been taken about the British Isles and southward to Madeira. Since the members of the Stromateiformes, to which the black ruffe belongs, occur more or less pelagically in temperate and tropical seas, it is not surprising that occasional stragglers are found far from their usual haunts.

Following is a brief description of the specimen at hand: Total length 528 mm. (20¾ inches); standard length 469 mm.; depth 134 mm.; head 98 mm.; eye 19 mm.; maxillary 36 mm. Dorsal rays 38; anal rays 25; pectoral rays 21. Scales very small, in about 185 rows. Opercle and preopercle finely serrate. Gill-rakers rather strong; length of longest about five-eighths the diameter of eye; 13 on lower limb of first arch. Teeth on jaws small, cardiform, in a single row. Lateral line arched along anterior one-fourth of body, then straight to base of caudal. Color black.

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Henry B. Bigelow and W. C. Schroeder, *Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.*

THE FOOD OF SMALL DOGFISH, *AMIA CALVA*.[1]—On July 2, 1934, I caught about two-thirds of a school of small dogfish (bowfin). The catch consisted of 19 pounds of fish, which ranged from 1¾ to 2¾ inches in total length. Since 1 pound contained 189 fish, the total was computed as 3,591 fish and the entire school was estimated to contain 5,500 individuals. The dogfish were taken in a small bay of the Lake Minocqua Thoroughfare, near the State Fish Hatchery at Woodruff, Wisconsin.

Ten of the dogfish were placed in an aquarium and the following day a dozen large-mouth bass fry, ¾ of an inch long, were also liberated in the same aquarium. The bass were viciously attacked by the dogfish and in a few seconds all were consumed. Thereafter, the dogfish were fed on beef liver and kidney, which they took readily.

Since the dogfish were captured in an area that is also the breeding place for other species of fish, namely large-mouthed bass, northern pike, muskellunge, bluegills and various minnows, the question arose whether dogfish of this size destroy the young of these species in nature. Consequently stomach analyses were made on a sample of 30 specimens. There was much similarity in the food found in the stomachs, with the exception that almost all of the larger fish (2 inches and longer) contained 1 to 5 damselfly nymphs, 7 to 15 scuds (*Hyalella*) and 4 or 5 small chironomid larvae. The smaller fish (under 2 inches) contained only 1 or 2 small individuals of the above-named forms. In all fish, the rest of the stomach was filled with plankton crustaceans, among which *Ceriodaphnia, Simocephalus* and *Polyphemus* predominated. Ostracods, *Cyclops, Sida* and *Diaptomus* followed in abundance in the order named. Phytoplankton, especially filamentous algae, was found in each specimen.

From these examinations, it is concluded that at this size, the dogfish in their natural habitat had not become piscivorous. They were, however, competing with the fry of other species for food, principally in their consumption of *Ceriodaphnia, Simocephalus* and *Polyphemus*.—Edward Schneberger, *Wisconsin Conservation Department, Sturgeon Bay, Wisconsin.*

[1] Published under a grant from the American Wildlife Institute for the publication of biological contributions fundamental to fish management.

SPAWNING AND MIGRATORY HABITS OF THE COLUMBIA RIVER STEELHEAD TROUT AS DETERMINED BY SCALE STUDIES.[1]—The construction of dams across the Columbia River endangers, to an unknown degree, the preservation of the valuable runs of salmonoid fish which have given that river the reputation of being the most important salmon stream in the world. The problems of getting the upstream migrating adult and the downstream migrating smolt past the newly formed barriers have been studied intensively, and numerous steps are being taken to insure normal migrations for the future.

Our study has been concerned with the downstream passage of the spawned steelhead trout which may have survived the rigors of the spawning activities. It has long been known that not all steelhead trout die after spawning; but, on the contrary, that a certain proportion survive, return to the ocean, and take part in subsequent spawning migrations. The proportion of these survivors in the Columbia river has never been determined. This quantitative knowledge is necessary to determine the importance of providing means for the surviving spawned steelhead trout to return to safety downstream, past the dams and turbines. If the proportion that now returns to the ocean is found to be so small that the absence of these veterans would constitute no significant loss to commercial fishermen, or if the proportion is so small that no insufficiency of spawn will result from the loss of these fish, then the loss of the survivors of spawning which might be caused by the dams need not be considered as serious. If, however, the proportion of fish that have returned to the ocean and then take part in a 2nd or 3rd spawning migration constitutes an important part of each steelhead trout run, it should be made possible for spawned steelhead to return to the ocean.

The proportion of a steelhead run which is formed by veteran spawners was determinded by means of scale examinations of scale samples of 1128 fish taken in the Columbia River at different places and seasons. Other determinations also were made possible by the examination of the scales.

The conclusions arrived at may be summarized as follows:

1. Only 3.4% of steelhead trout in the Columbia River show spawning marks, indicating that they have spawned before. Such a small percentage of the run being formed by fish showing spawning marks indicates that only a small proportion of a run survives to return to the ocean. These results make very questionable the advisability of spending large sums of money for the construction of fishways designed to allow the few steelhead that survive spawning activity to return to the ocean.

2. Steelhead trout spawning for the 2nd time constitute a higher percentage of winter-run fish than of either summer- or fall-run fish—2% of the summer run, 4% of the fall run, and 12% of the winter run is constituted by veterans.

3. Of the steelhead trout that have spent 2 years in fresh water before going to the ocean: 22% start their 1st spawning migration in the 2nd year of ocean life, 68% migrate in the 3rd year of ocean life, and 9% migrate in the 4th year of ocean life.

4. Of the steelhead trout that have spent 3 years in fresh water before going to the ocean: 39% start their 1st spawning migration in the 2nd year of their ocean life, 51% migrate in the 3rd year of ocean life, and 9% migrate in the 4th year of ocean life.

5. 13% of the steelhead spawning for the 1st time are 4 years old, 58% are 5 years old, 25% are 6 years old, 4% are 7 years old, and less than 1% are 8 years old.

6. The size of a mature steelhead trout does not depend significantly upon the number of years which the young fish has spent in the fresh-water streams.

7. The relative position of the last winter check on the scale varies, in most fish, with the time of the year. About 90% of the fish caught in the winter show winter checks on the margin of the scales; about 68% of the fish caught during the summer and fall showed no winter check at the edge; that is, growth was observed at the edge of the scales. The reason why some summer and fall fish show no summer growth at the edge of the scales has not been completely explained.—JOHN B. LONG and LAWRENCE E. GRIFFIN, *Department of Biology, Reed College, Portland, Oregon.*

[1] Published under a grant from the American Wildlife Institute, for the publication of biological contributions fundamental to fish management; this note was read at the nineteenth meeting of the Society, on August 31, 1936.

NOTES ON CALIFORNIA FISHES.—Recently some new information has been obtained regarding the characters and distribution of several marine fishes of California:

1. *Strongylura exilis* (Girard).—A typical specimen of this needlefish, 427 mm. in standard length, taken by G. H. Clark off San Francisco, November 12, 1934, in 50 fathoms, extends the recorded range of the species about 250 miles northward from Point Conception.

2. *Jordania zonope* Starks.—One specimen of this species was regurgitated by a rock cod (*Sebastodes* sp.) taken off Point Joe, at 36° 38′ N. Lat., 121° 57′ W. Long., in 21 fathoms, on April 23, 1931. Another was taken from a tide-pool on Point Lobos, at 36° 31′ N. Lat., 121° 57′ W. Long., on July 9, 1933. These are the only specimens known from south of Puget Sound. Their fin formula is D. XVIII, 16 or 17; A. 22 or 23; P. 14; V. I, 5. There are from 51 to 53 scales in the lateral line.

3. *Paricelinus hopliticus* Eigenmann and Eigenmann.—On comparing the types of *Paricelinus hopliticus* and *P. thoburni* Gilbert at the United States National Museum, I have found them to belong to the same species. The type of *P. hopliticus* does not have barbels on the lower jaw as stated in the type description (Eigenmann and Eigenmann, 1889: 131); the authors apparently interpreted as barbels a pair of small muscles, possibly geniohyoids, which run to the symphysis and which are free posteriorly due to being partly digested. Their "strong, upward directed spines" on the suborbital stay are but slightly larger than the posterior elements of Gilbert's "crowded smaller spines" (Gilbert, 1896: 432, pl. 30). The maxillary in each type is about 3 in head. Although the type of *hopliticus* is so badly digested that it is impossible to tell whether there was a slit behind the last gill or not, the 2 specimens agree well in all other regards when compared point by point.

Another badly digested specimen, in the collections of the United States Bureau of Fisheries (No. 597), from Albatross station 3052, off Florence, Oregon, at 44° 00′ N. Lat., 124° 57′ W. Long., in 48 fathoms, represents the northern limit of the known range.

A fourth specimen of this rare and interesting fish, 157 mm. in standard length was collected off Shelter Cove, California, at 39° 53′ N. Lat., 124° 07′ W. Long., in 100 fathoms, on September 5, 1935. Its 3rd preopercular spine of the right side is narrowly bifid. A strong spine on the cleithrum extends upward and backward from slightly behind the posterior end of the subopercle. The ventrals extend to the anus. D. XII, 18; A. 23; P. 14 or 15; V. I, 5 (last ray of second dorsal and anal split to the base and counted as one). Spinous scales in lateral line 44 or 45; 35 scales in the enlarged dorsal band.

4. *Artedius corallinus* (Hubbs).—Eight specimens of this species, hitherto known only from the unique type, are at hand. They measure from 41 to 91 mm. in standard length. Two specimens are from Monterey Bay, at 36° 37′ 19″ N. Lat., 121° 54′ 12″ W. Long., in 5 to 6 fathoms; 3 are from tide-pools on Point Lobos, the type-locality; 2 are without data; the 8th specimen, from a tide-pool at Ensenada, Mexico, extends the known range about 400 miles southward.

This species was made the type of a new genus, *Allartedius*, by Hubbs (1926: 8), but the characters of teeth and squamation used for differentiation seem to me to be of much less than generic significance. The teeth are appreciably larger than in *Artedius lateralis* (Girard), but they do not differ at all in shape and arrangement. The importance of the numerical differences in the dorsal scale bands is diminished by the extensive degree of variation in both species: *A. lateralis* has 25–29 diagonal series of scales with 6–11 scales in the longest row, while *A. corallinus* has 39–50 series with 10–18 scales in the longest one. Further, I can see no significant difference between the lateral line scales of the two species; those of *A. lateralis* are well developed and serrulate.

The fin formula is D. IX, 15 or 16; A. 12 or 13; P. 15 or 16; V. I, 3. The last ray of the second dorsal and anal fins is not counted as double, since dissections of the closely related form *A. lateralis* show that the last 2 rays are distinct, and separately articulated to different interneurals, and that both together are not to be considered as equal to the last, completely split ray of such fishes as *Paricelinus hopliticus*. *A. corallinus* has from 3 to 8 small scales below the lateral line, at a point just above and behind the upper end of the pectoral base.

MEASUREMENTS IN HUNDREDTHS OF THE STANDARD LENGTH.—Origin of first dorsal to pelvic base, averaging 22.1 (ranging from 20.0 to 25.1); least depth of caudal peduncle, 8.1 (7.2 to 9.1); distance between dorsal ends of pectoral bases, 23.2 (20.1 to 27.7); length of head, 38.5 (37.8 to 40.8); diameter of orbit, 9.4 (8.2 to 10.6, decreasing with age); length of snout, 11.4 (10.1 to 12.5); length of upper jaw, 19.8 (18.9 to 20.3); snout to origin of first dorsal, 33.0 (32.0 to 34.6); base of first dorsal, 20.6 (17.9 to 23.0); snout to origin of second dorsal, 55.3 (53.4 to 57.2); base of second dorsal, 34.7 (32.9 to 37.3); snout to anal, 59.0 (56.8 to 64.1); base of anal, 26.9 (24.8 to 28.9); snout to upper end of pectoral base, 36.1 (34.3 to 38.2); width of pectoral base, 12.4 (11.4 to 13.0); length of pectoral, 29.8 (28.8 to 31.2); snout to pelvic base, 31.8 (28.1 to 34.5); length of pelvic, 15.6 (13.9 to 19.8); length of caudal, 23.1 (21.9 to 25.2).

5. *Xeneretmus leiops* Gilbert.—The range of this species, previously known only from the type-locality, Albatross station 4110, off Catalina Island, is extended a little more than 300 miles northward on the basis of 2 specimens from Monterey Bay, at 36° 49′ N. Lat., 122° 30′ W. Long., in 200 fathoms. One additional specimen is at hand from off Point Sur, at 36° 20′ 45″ N. Lat., 122° 06′ 15″ W. Long., in 208 fathoms.

The fin formula is D. VII, 7 or 8; A. 6 or 7; P. 14; V. I, 2. The depth of the interorbital groove, varying greatly, is shallowly concave in 1 specimen and deeply grooved in another, intermediate in the third specimen. The length of the 10th pectoral ray measures 1.2 to 1.3 times in the 11th; the difference in the length of these rays is somewhat less than noted by Gilbert (1915: 348, pl. 17, fig. 11), in whose work it should be noted that the figures of *Xeneretmus leiops* and *X. ritteri* have been transposed on the plate.

6. *Bryostemma nugator* Jordan and Williams.—A specimen 95 mm. in standard length from a tide-pool on Point Lobos, at 36° 31′ 07″ N. Lat., 121° 57′ 14″ W. Long., extends the known range of this species southward to a new limit. The fin formula is D. LIII; A. I, 39; P. 14; V. I, 4. The types, which I have examined, also have 4 soft-rays in the pelvics instead of 3 as stated in the type description (Jordan and Williams, in Jordan and Starks, 1895: 843, pl. 101).

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ROLF L. BOLIN, *Hopkins Marine Station, Pacific Grove, California.*

ALBINISM IN *ICTALURUS PUNCTATUS*.—On October 3, 1936, Conservation Officer W. W. Trusell, of Sioux City, Iowa, secured from two commercial fishermen on the Missouri River, bordering Woodbury County, a pure albino channel catfish. The fishermen were using a 2½-inch bar mesh trammel net. The fish weighed one pound and 12 ounces and was 14½ inches long (standard length). The specimen is entirely milk white and no dark coloring appears on any part of the fins or integument. The eyes are deep red. When taken the fish appeared perfectly normal in other respects and was kept alive in an aquarium for 22 days. It was noted, however, that the specimen was much livelier at night than during daytime periods. Because the fish began to grow weak and emaciated it was placed in fixing solution for further study.—W. W. AITKEN, *Iowa Conservation Commission, Des Moines, Iowa.*

FIRST RECORDS OF THE SMELT, *OSMERUS MORDAX*, IN LAKE ERIE.[1]—On June 30, 1936, two specimens of the smelt, *Osmerus mordax* (Mitchell), were received from Captain George B. Parsons, a commercial fisherman at Vermilion, Ohio. These are

[1] Published by permission of the U. S. Commissioner of Fisheries.

the first specimens of smelt received from Lake Erie. The specimens were taken in gill-nets set 16 miles NNE. of Vermilion, Ohio, and measured respectively 123 mm. and 135 mm. in standard length (5.6 inches and 6.2 inches, total length). Both individuals were sexually immature and in their 2nd year of life (hatched in 1935). The stomachs of both were empty. The specimens have been deposited in the Museum of Zoology, University of Michigan (Cat. No. 103359).

Captain Parsons informed me that the first smelt taken by him were caught on about June 20, 1936, that about 12 or 15 were taken by him during the last week of June, and that a total of some 35 or 40 smelt were taken by the other gill-net fishermen at Vermilion, Ohio. According to reports no smelt were taken off Vermilion, Ohio, after June. On November 26, 1936, Captain George Leidheiser of Vermilion, Ohio, informed me that he had taken smelt in gill-nets as early as April, 1936, in the island region in the western end of Lake Erie, and that he also took specimens in November off Ashtabula, Ohio. In a letter of November 26, 1936, Mr. Carl F. Kolbe of Port Dover, Ontario, wrote, "We thought you might be interested to know that the odd smelt was taken here in 1935 and this summer each boat has been reporting from one to six fish daily which were caught by the teeth in their whitefish nets. . . . These fish run 8 to 10 inches in length and weigh from two to four ounces each."

In a letter of March 25, 1937, Captain Parsons again reported the presence of smelt in gill-nets set off Vermilion, Ohio. He wrote, "We have caught a few smelt since we started to fish this spring and they are much larger than last year's fish." The specimen (Museum of Zoology, University of Michigan, Cat. No. 114927) received from Captain Parsons on March 24, 1937, substantiated his statement. This fish, a female filled with eggs, measured 203 mm. in standard length (9.5 inches total length), weighed 3¾ ounces, and had completed two years of growth (age-group I). Investigators have found that female smelt of this size in the upper Great Lakes are at least three years old. No identifiable material was found in the stomach of Captain Parson's specimen.

In a letter of March 27, 1937, Mr. Charles E. Lay, Sandusky, Ohio, reported the capture of two smelt in trap-nets set out of Port Clinton and of one smelt taken in a trap-net off Huron, Ohio. These are the first records of smelt taken in the trap-nets of Lake Erie.

It appears then that the smelt is firmly established in Lake Erie. The species undoubtedly migrated from southern Lake Huron and Lake St. Clair where it was first reported in April, 1932.

Reports have been circulated widely (Creaser, 1932) that hundreds of adult smelt were released into the Detroit River in the spring of 1932 by the Belle Isle Aquarium at Detroit. If this were true the Lake Erie specimens could very well have been the descendants of the released Aquarium fish. However, Mr. John W. Ireland, Curator of the Aquarium, informed me (letter of August 6, 1936) that no smelt were ever released by the Aquarium into any waters connected with the Great Lakes system. It is true that in 1932 smelt were liberated into the canals on Belle Isle but, he writes, "these canals were absolutely blocked off by dams so that no water went into the Detroit River. These smelt were held captive in the waters of the Belle Isle canals and we have found no trace of any smelt in these canals since that time. On three different occasions these canals were drained and cleaned out and I am satisfied that no smelt could live in these waters."

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John Van Oosten, *United States Bureau of Fisheries Research Laboratory, University of Michigan, Ann Arbor, Michigan.*

Herpetological Notes

FURTHER NOTES ON THE TURTLES OF THE NORTH PACIFIC COAST OF NORTH AMERICA.—In two recent papers (Univ. Calif. Publ. Zool., 32, 1930; 429–441; COPEIA, 1932, 9–11)[1] I have set forth certain items concerning the distribution of the freshwater turtles of the Pacific Coast. Recent opportunity to discuss the subject with several persons in the Pacific northwest and to examine Lord's specimens has made it possible to correct, confirm, and amplify some of the statements previously made.

The situation as to turtles on Vancouver Island is still complicated. None of several persons well acquainted with the Island, with whom I talked in June, 1933, had ever heard of any native turtles there nor were any specimens of authentic data known to be in collections. But in September, 1934, Mr. F. Kermode of the Provincial Museum at Victoria forwarded to me for examination a specimen of *Chrysemys bellii bellii* taken from Paterson Lake, near Great Central Lake, Vancouver Island. This specimen is now in the Provincial Museum. The specimen had 16 dorsal plates (5:6:5), and 12 marginals on each side. The legs were yellowish instead of reddish.

In view of the recent activities in transplantation and release of turtles mentioned below, and the failure of various collectors in past decades to obtain turtles from the Island, the species cannot with certainty be accorded the status of a native. Older statements, and particularly those pertaining to *Clemmys marmorata* on Vancouver Island should, therefore, be disregarded.

In April, 1934, I had an opportunity to examine the specimens of turtles collected by J. K. Lord and G. M. Dawson in northwestern United States that are now in the British Museum of Natural History in London. As heretofore recorded by others, all are *Chrysemys* and typical of *bellii* as defined by Bishop and Schmidt. The type used by Gray (no. 82) is a "stuffed" exhibition specimen, the data are simply "G. M. Dawson coll. British America." The study collection specimens are "b. c. ad. shells, British Columbia, J. K. Lord. [and] d yg. spirit Walla Walla, British Columbia J. K. Lord." On the bottle containing the latter are the following entries: first, "Actinemys marmorata Presd by J. K. Lord Esq," then, in another hand, "Chrysemys Bellii Chrysemys picta var 3 p. Walla Walla see Brit. Columbia II. p. 301" [the latter obviously a reference to the mention of this specimen in Lord's book]. After the word *marmorata,* which is partly crossed out, is written in the later hand "Lord not Agassiz."

In 1929, Mr. Harlan I. Smith, Dominion Archaeologist, obtained some turtles in McCoy Lake, near Alberni on Vancouver Island, that were indentified by Mr. Clyde L. Patch of the Canadian National Museum as *Damonia* sp.[= *Clemmys?*]. This is an oriental genus. Since Chinese have been resident on the Island for years, and are noted for their habit of importing various animals from their home country, it seems likely that the turtles arrived through this means, as presumably did J. J. Rivers "soft-shelled turtle" of the Sacramento River in California (Van Denburgh, 1917). According to George P. Holland of Vancouver (letter, October 9, 1934), a Chinese curio dealer, Teen Jore, with stores in both Victoria and Vancouver, frequently stocks *Damonia reevesi;* possibly the animals found by Harlan Smith were escaped pets or their descendants. According to Mr. Holland the species seems to thrive in captivity in the local climate. Mr. W. B. Anderson (of the Entomological Branch, Dominion Department of Agriculture, Victoria) who has travelled extensively in many parts of British Columbia told me in 1933 that there are turtles on Texada Island adjacent to Vancouver Island [species unknown, but I would expect *Chrysemys bellii bellii*—T. I. S.]. The same informant also stated that there are turtles [species not known] at Pender Harbour on the mainland north of Vancouver. Logier (Trans. Royal Canadian Institute, 18, part 2, 1932: 333–334) has summarized the existing records for *bellii* elsewhere in British Columbia; it is reported only near the southern border of the province, especially in the Okanagan drainage. Mr. T. L. Thacher is reported (Geo. P. Holland, letter, October 16, 1934) to have released a number of specimens of *bellii* at Hope, British Columbia, "a few years ago"; the species is reported to be breeding and increasing quite rapidly.

There is still a paucity of information on turtles for the state of Washington,

[1] Full citations to items in the literature mentioned in the present article will be found in these previous papers.

west of the Cascades. Cooper's remarks (1860) are puzzling in the light of my knowledge. Surely if, as he said, turtles were "common in freshwater ponds and rivers west of the Cascades" [in Washington] specimens should be forthcoming. Yarrow (Bull. U. S. Nat. Mus., 24, 1883: 35) lists one specimen of *Chrysemys bellii* from Fort Walla Walla, Washington Territory, collected by Bendire in 1881, and (p. 36) one of *"Chelopus marmoratus"* from Fort Steilacoom, Washington Territory, collected by Dr. George Suckley; he lists also four specimens of the latter from "Puget Sound, Oregon" without data or name of collector. There is also, in the Museum of Comparative Zoology at Cambridge, Massachusetts, a J. G. Cooper specimen from Ft. Steilacoom. As turtles are now quite likely to be transported from place to place by irresponsible persons the need for checking the situation in western Washington at an early date is evident.

It is quite likely that *C. b. bellii* occurs scatteringly in Washington east of the Cascades; Cooper *(loc. cit.)* mentions turtles seen on the Yakima River and J. R. Slater of Tacoma has records of turtles from east of the Cascades. Blanchard (1921) recorded *bellii* from near Springdale, Stevens County, and there are several records from the vicinity of Walla Walla (Lord, 1866; Storer, 1930, 1932).

In Oregon, Stanley G. Jewett, Jr., of Portland, states that *bellii* is present westerly along the Columbia to the vicinity of Portland and southerly up the Willamette River to the vicinity of Cottage Grove, Lane County. On July 2, 1933, I collected a *Clemmys marmorata* that was crossing the highway along the Umpqua River close to Canyonville, Douglas County. It proved to be a female, containing eggs. In Grants Pass I was told that turtles occur in the Rogue River.

The above details, in conjunction with previous information, give a somewhat more logical explanation to the distribution of freshwater turtles on the north Pacific Coast. *Clemmys marmorata* is the sole species of the California fauna west of the Sierra-Cascade divide. It penetrates this mountain chain along Pit River (at least to Fall River Mills, Shasta County), and along the Klamath River (whence the record for Lower Klamath Lake by Van Denburgh). Coastwise, in California, Dr. Joseph Grinnell reports (letter, December 14, 1933) having found this species on Mad River, Trinity County, close to the Humboldt County line (Mus. Vert. Zool. nos. 14601-08), but only in localities "inside the coastal fog belt proper, where there were long daily periods of sunshine, and where the forest and canyon walls did not close in on the ponds of quiet waters." In Oregon it evidently occurs on the Rogue and Umpqua rivers, but not farther to the north. In Washington, Fort Steilacoom is the only definite station of record. There is no reliable evidence of its occurrence north of the Canadian boundary.

Chrysemys bellii bellii, on the other hand, reaches west along the Columbia River drainage and down its westernmost major tributary, the Willamette, and is probably present also along other inland tributaries of the Columbia. It ranges northeast of the Cascades through eastern Washington to the Okanagan drainage in southern British Columbia. Its status in the Vancouver area is uncertain and its presence on Vancouver Island may be that of a transplant.—TRACY I. STORER, *Division of Zoology, University of California, Davis, California.*

SOME FURTHER NOTES ON THE AMPHIBIANS AND REPTILES OF THE PETEN FOREST OF NORTHERN GUATEMALA.—During the winter and spring of 1935 Dr. C. L. Hubbs and Dr. Henry van der Schalie of the Museum of Zoology, University of Michigan, continued the biological explorations of the Yucatan Peninsula which have been the objective of the Museum of Zoology in cooperation with the Carnegie Institution of Washington for the past eight years. This expedition, while primarily interested in fish and molluscs, collected about 300 specimens of amphibians and reptiles belonging to 35 species in the Peten region. The party worked first in the vicinity of Laguna de Peten and then proceeded southward to the source of the Rio de la Pasion in Alta Vera Paz, though never going beyond the limits of the Peten bush. All the localities listed below are to be found either in L. C. Stuart (Univ. Mich. Mus. Zool., Misc. Pub. 29, 1935: map) or Claudio Urrutia ("Mapa de la Republica de Guatemala," 1:400,000, 1924, L. Friederichsen and Co., Hamburg).

Although most of the material represents well-known species, the expedition added materially to our locality records and in addition collected several forms new to the area as well as several unrepresented in the Museum of Zoology collections. Of particular

interest are *Centrolene fleishmanni* (Boettger), *Anolis pentaprion* Cope, and *Tretanorhinus nigroluteus* Cope, all taken for the first time within the Peten bush. Other species worthy of notice are the rare *Tantilla moesta* (Günther), the eggs of *Clelia petola* (Linnaeus), a fine collection of *Staurotypus salvini* Gray, and an excellent series of *Crocodylus moreletii* Duméril which for all practical purposes may be considered topotypic. The amphibians were identified by Mrs. H. T. Gaige of the Museum of Zoology and the turtles by Dr. N. E. Hartweg of the same institution. All the specimens are preserved in the collections of the Museum of Zoology and are as follows:

Rhinophrynus dorsalis Duméril and Bibron

Flores.

Bufo marinus (Linnaeus)

*Laguna de Peten, at Flores and east of Flores; Santa Ana road south of Flores; Puebla Nueva; Laguna Perdida; *Laguna Eckibix; La Libertad, *at Aguada Copul and *Aguada Copo; Rio de la Pasion, at San Diego, Tres Islas, near Alta Vera Paz border, and *north of Ceiba; junction of Rio de la Pasion and Rio Santa Amelia; Arroyo de Petexbatum at Sayaxche; *Rio Chajchinic, near Alta Vera Paz border. Asterik (*) indicates only tadpoles.

Bufo valliceps Wiegmann

El Paso de los Caballos; Rio de la Pasion, 13 miles above Sayaxche and at Tres Islas; Arroyo San Martin; Rio Chajchinic.

Leptodactylus labialis (Cope)

Laguna de Peten east of Flores.

Leptodactylus melanotus (Hallowell)

El Paso de los Caballos; La Libertad at Aguada Chimax; Laguna de Zotz; Arroyo Subin at Santa Teresa; Rio de la Pasion, at Sayaxche, 13 miles above Sayaxche, and at lower playa of Cambio; Arroyo San Martin.

Hyla culex Dunn and Emlen

El Paso de los Caballos.

Centrolene fleishmanni (Boettger)

Arroyo Subin at Santa Teresa.

This is the most northern record of this apparently wide-ranging species and the first to be recorded from Peten. It was found among the water hyacinth.

Rana palmipes Spix

El Paso de los Caballos; Laguna de Yalac; Laguna de Zotz; Arroyo Subin at Santa Teresa; Rio de la Pasion 13 miles above Sayaxche; Rio Santa Amelia (at mouth).

Rana pipiens Schreber

Laguna de Peten east of Flores; Laguna de Zotz; El Paso de los Caballos; Rio de la Pasion at San Diego.

Sphaerodactylus glaucus Cope

Flores.

Sphaerodactylus lineolatus Lichtenstein

Puebla Nueva.

Anolis biporcatus Wiegmann

Laguna de Zotz; El Paso de los Caballos; Rio de la Pasion at Ceiba (Alta Vera Paz).

Anolis pentaprion Cope

Ceiba.

This is the first record of this species from the Peten bush. Although Barbour states Bull. Mus. Comp. Zool., lxxvii, 4, 1934: 145) that this species ranges only as far north as Nicaragua, the Museum of Zoology has a fine series in its collections from Honduras.

Anolis ruthveni Stuart

Ceiba.

Anolis tropidonotus Peters

Arroyo de Ponteil near Flores.

Anolis ustus ustus Cope

Laguna Eckibix.

Basiliscus vittatus Wiegmann

Flores; Tayasal; El Paso de los Caballos.

Ctenosaura similis (Gray)

Flores; Tayasal; shore of Laguna de Peten southeast of Flores.

Sceloporus teapensis Günther

Shore of Laguna de Peten southeast of Flores.

Lepidophyma flavomaculatum Duméril

Along Rio de la Pasion near Peten-Alta Vera Paz border (exact locality unknown).

Constrictor constrictor imperator (Daudin)

Shore of Laguna de Peten between Punta de Vixil and Punta de Nima.

Tretanorhinus nigroluteus Cope

El Paso de los Caballos; Laguna de Yalac; Arroyo Subin at Trinidad.

It is unfortunate that the Museum of Zoology lacks material from the Isle of Pines and southern Central America to compare with this fine series, so that it is impossible to comment on the status of *nigroluteus, lateralis,* and *insulae-pinorum.* All of the above Gautemalan series have 21 rows of dorsal scales and are dark brown above with a light lateral stripe on scale rows three and four, which becomes obsolete in the larger specimens. A series of very dark dorso-lateral spots on either side alternate with each other and tend to fuse anteriorly, forming a zig-zag dorsal pattern. The belly and underside of the tail are light, heavily mottled with brown, while the chin and throat are immaculate gray-brown.

Dr. Hobbs informs me that this purely aquatic ophidian dives to the bottom when surprised and there seeks protection in the crevices of rocks, etc., from which no amount of confusion can disturb it. One of the specimens was caught in a gill net from which it had stolen a *Cichlosoma octofasciatum* (Regan). These specimens are the first to be recorded from Peten.

Leptophis occidentalis occidentalis (Günther)

La Libertad.

Xenodon colubrinus Günther

El Paso de los Caballos.

Clelia petola (Linnaeus)

El Paso de los Caballos.

The above series includes three specimens which were accidentally torn from the eggs and four others still covered with the egg membrane. Dr. van der Schalie discovered the clutch beneath a log which he had turned over while searching for molluscs. Unfortunately they do not represent the entire nest as several were accidentally destroyed in tearing the log apart. Dr. van der Schalie believes that the clutch probably totaled about ten.

The specimens free of the membrane are all fully developed, with the egg-tooth plainly visible. The single male has the penis extruded and the yolk-sac which is still intact is very small. The clutch was undoubtedly about to hatch when found (March 15, 1935).

The egg-membrane is tough and leathery, light brown in color, and with faint, irregular striations. The eggs are perfectly elliptical and measure as follows:

Specimen	Condition	Length in mm.	Breadth in mm.
A	perfect	34	18.5
B	slightly flattened	31	19 (average)
C	slightly ripped	31.5	..
D	badly ripped	about 33	..

The three specimens free of the membrane are colored as adults from the region and measure as follows:

Specimen	Sex	Body lg. in mm.	Tail lg. in mm.
E	♀	157	..
F	♀	155	43
G	♂	153	48

Hydrocalamus quinquevittatus (Duméril and Bibron)

Flores.

Tantilla moesta (Günther)

Flores.

Bothrops atrox (Linnaeus)

El Paso de los Caballos; La Libertad.

Staurotypus salvini Gray

Laguna de Peten, near Puebla Nueva, at Flores, and southeast of Flores; Laguna de Zotz; Rio San Pedro at El Paso de los Caballos; Laguna de Yalac; Laguna Eckibix; Arroyo de Ponteil near Flores.

Kinosternon berendtianum Cope

San Benito and vicinity.

Kinosternon leucostomum Duméril

Laguna de Peten southeast of Flores; Flores (?).

Dermatemys mawii Gray

Rio San Pedro at El Paso de los Caballos and 60 miles below El Paso de los Caballos; Laguna Perdida; Laguna Petenxil; Rio de la Pasion at San Diego and above mouth of Rio Santa Amelia; Arroyo de Petexbatum at Sayaxche.

Pseudemys ornata (Gray)

Laguna de Peten at Flores; Laguna de Zotz; Rio San Pedro at El Paso de los Caballos; Aguada at Chachaclun; Aguada Copo at La Libertad; Laguna Eckibix.

Geoemyda areolata (Duméril)

Flores.

Crocodylus moreletii Duméril

Laguna Petenxil; Laguna de Zotz; Laguna Perdida; Rio San Pedro at El Paso de los Caballos; Arroyo Subin at Santa Teresa.

L. C. STUART, *Museum of Zoology, Ann Arbor, Michigan.*

THE TYPE DESIGNATIONS OF THE OPHIDIAN GENERA *CERASTES* AND *CORONELLA*, ESTABLISHED BY LAURENTI IN 1768.—To the very valuable paper of Leonhard Stejneger (COPEIA 3, 1936: 133–141) on the types of Amphibian and Reptilian genera proposed by Laurenti in 1768 I wish to give two emendations.

1. *Cerastes* Laurenti. Stejneger (*l.c.*: 139) has designated *Cerastes candidus* Laurenti as the type of the genus *Cerastes* Laurenti. As *Cerastes candidus* is identical with *Coluber haje* Linnaeus, the generic name *Cerastes* Laurenti ought to become a synonym of *Naja* Laurenti. But unfortunately a prior definite type designation of *Cerastes* Laurenti had been established by Fejérváry (Zool. Anz. 56, 1923: 172), who selected *Coluber rhombeatus* Linnaeus. Thus the generic name *Cerastes* is not inactive in herpetological nomenclature, but is the valid name of the genus commonly known as *Trimerorhinus* Smith 1847, which therefore becomes a synonym of *Cerastes*. Another synonym of *Cerastes* is *Psammophylax* Fitzinger 1843, which has the same genotype as *Cerastes* and *Trimerorhinus*.

2. *Coronella* Laurenti. The first type designation of this genus was not made, as stated by Stejneger (*l.c.*) in 1860, by Cope, who selected *Coronella austriaca*. Long before, the same genotype of *Coronella* (namely *Coluber laevis*) had been definitively designated by Boie (Isis, 20, 1827: 519).—ROBERT MERTENS, *Senckenberg-Museum, Frankfurt a.M., Germany.*

THE OCCURRENCE OF *HYLA AVIVOCA* VIOSCA IN WESTERN TENNESSEE.—More than a year ago the writer began to suspect that this species, which had been reported only from points farther south, was in this region but not until May, 1936, did he investigate the matter sufficiently to establish fully their presence and identity. On the nights of May 20, 21, 1936, we collected eighteen specimens in the South Fork, Forked Deer River bottom, near Henderson. A few of these specimens were sent to Dr. A. H. Wright, Cornell University, who checked and confirmed our classification of them. The place where they were found is characteristic of their typical habitat as given for other places—a tupelo, cypress, birch, and buttonbush swamp. All specimens were found within a short distance of the water. They appear to be fairly abundant in this region in places and we think that it is probable that this species may be found as far up the Mississippi Valley as southern Illinois.—J. R. ENDSLEY, *Freed-Hardeman College, Henderson, Tennessee.*

NEW RECORDS OF AMPHIBIA FOR OKLAHOMA.[1]— During the past five years the writer has taken an active interest in the amphibia of Oklahoma and has collected them in several regions of the state. No new records have been obtained from the area immediately adjacent to Norman, but during the summer of 1934 six species not hitherto recorded from the state were taken in McCurtain County in extreme southeastern Oklahoma. Throughout this period the writer was associated with a field party of interested biologists who subsequently turned over the results of the summer's work to the University of Oklahoma Museum of Zoology. This party was composed of Mr. and Mrs. Mark Holcomb, Mr. and Mrs. H. L. Whitaker and the writer.

The work was aided by a grant from Dr. Howard Atwood Kelly, of Baltimore, Maryland, and by the loan of equipment from the University of Oklahoma Biological Survey. The *Ambystoma* were identified by Dr. K. P. Schmidt, the Anura by Mrs. H. T. Gaige and Dr. Charles Walker. Dr. J. T. Self, of Norman, Oklahoma, has given the writer permission to record a specimen of *Hyla cinerea* taken by him in the summer of 1933.

Ambystoma opacum (Gravenhorst).—Four specimens of the marbled salamander were taken between July 27 and August 17, from under logs along spring-fed branches of the wooded bottomlands bordering Mountain Fork River, 13.5 miles southeast of Broken Bow. The individuals were found singly, partially embedded in the rich, moist soil. The short, stocky, black body and the silvery grey bars distinguish this form from other species of *Ambystoma* now known from Oklahoma.

Ambystoma maculatum (Shaw).—A single specimen (U. O. M. Z. 17546) was taken from under a log in the same general neighborhood as the specimens of *A. opacum* on August 6. The black body marked with two dorsal, longitudinal rows of bright yellow spots are the distinguishing characters of this species.

Siren lacertina Linné.—Stejneger and Barbour (Checklist, 3rd ed., 1933) give the range of this form as "Swamps of South Carolina, lower Georgia and Florida." The single specimen of this species taken from the black, muddy ooze of a stick-bestrewn, spring-fed branch 12 miles southeast of Broken Bow, on July 29, thus extends the range several hundred miles westward. It was associated with large numbers of *Desmognathus fuscus brimleyorum*. The specimen at hand has a total length of 181 mm., tail 60 mm., arm 4 mm., forearm and hand 8 mm. The body is cylindrical, head flattened, snout truncate, tail compressed, 30–32 lateral grooves. Color in alcohol: Body *dark mouse grey* above shading to *dark Quaker drab* ventrally. Throat, belly and sides spotted with fine white dots which fade out posteriorly. A broad creamy white lateral band extends posteriorly from the upper angle of the jaws, becoming finer and disappearing about 60 mm. posterior to the snout.

Pseudacris nigrita triseriata Wied.—A single specimen taken from under a log 12 miles southeast of Broken Bow, August 11, has been referred to this species by Dr. Walker. The confused nomenclature of the genus makes it difficult to discuss the relationship of this specimen to other *Pseudacris* known from Oklahoma.

This specimen has a total length of 63 mm., hind legs 38 mm. The body is brownish grey dorsally with three darker, uninterrupted longitudinal bars. The median bar extends from the tip of the nose posteriorly to the urostyle while the two lateral bars originate at the level of the arms and terminate just in front of the legs. The flanks are greyish and granulate. The throat, stomach and under surfaces of the limbs are creamy and the legs are irregularly barred above with brownish. Compared to *P. n. clarkii:* it is a smaller, relatively more slender species, with thinner and longer hind legs, proportionately longer toes and slightly blunter nose. The dorsal stripes of *P. n. clarkii* are a rich green in life, the dorsal stripes of the species in hand were dark brown.

Hyla cinerea cinerea (Schneider).—Dr. J. T. Self collected a single specimen of this form from the branches of a small bush on the margin of Broken Bow Lake a few miles north of Broken Bow, McCurtain County, during August, 1933. Although no specimens of this *Hyla* have been collected by the writer they were heard in great numbers along Mountain Fork River, 13.5 miles southeast of Broken Bow, McCurtain County, during the latter part of July and the fore part of August, 1934. They seemed to be congregated in the cypress sloughs which extend back from the river.

Hyla crucifer Wied.—Three examples of the spring peeper were taken southeast of

[1] Contribution from the Zoological Laboratory of the University of Oklahoma. Second series, No. 158.

Broken Bow during August, 1934. The first specimen was found sitting on a small stone in the middle of the partially dry stream bed of a spring-fed branch at noon. Another was taken from under a log in a dry slough and a third was taken from the edge of a shallow slough in a cypress swamp. Although many examples of *Hyla versicolor versicolor* were taken farther north in McCurtain County and LeFlore County, no individuals of this species were seen. It is probably rather rare in Oklahoma. The small size, oblique cross-shaped mark on the back and the dark V-shaped mark between the eyes separate *H. crucifer* from other Oklahoma hylas.

Rana palustris LeConte.—A good series of the pickerel frog was taken in McCurtain County. Between July 6–14, several specimens were shot along the banks of Eagle Fork Creek and Mountain Fork River three miles southwest of Smithville. Many specimens were taken from under logs in the moist bottomlands along Mountain Fork southeast of Broken Bow. It may be separated from *Rana sphenocephala*, which occupies the same area, by the two dorsal rows of large, squarish dark spots and by the orange or yellow coloring of the undersides of the arms, legs, groin, and sides of the belly.—A. H. Trowbridge, *Department of Zoology, University of Oklahoma, Norman, Oklahoma.*

NOTES ON *LEPTODACTYLUS LABIALIS* (Cope).—*Leptodactylus labialis* (Cope) was originally described from specimens taken in Mexico in 1877. Kellogg in his "Mexican Tailless Amphibians in the United States Museum" (1933), considered this continental form synonymous with *Leptodactylus albilabris* (Günther), which is the insular form found on St. Thomas and other West Indies islands. In 1932 Taylor[1] described a single specimen of a Leptodactylid taken at Rio Grande City, Texas, during the summer of 1931, and following common usage, designated it as *L. albilabris*. However, after examining a large series from the same general area, the author feels that this should have been *L. labialis* as several points of difference are noted. Schmidt [2] and Gaige[3] both concur in such a designation.

The finding of tadpoles, transforming young and a frothy egg mass on June 8, 1935, immediately following heavy rains ten miles northwest of Edinburg, Texas, closed some gaps in the knowledge of the life history of this amphibian. The egg mass containing 86 yellow eggs was found in a rounded excavation about 4 cm. in diameter and 3 cm. deep at the base of a grass hummock a foot from the water edge and several inches higher than the water level.

These eggs, around which no hyaline sheath could be discerned, measured 1.5 mm. in diameter. Within 40 hours after the eggs were laid, the young hatched and were practically invisible except for two dark eye spots and the yellow yolk sack. Several hours later light brown pigmentation appeared. The emerging tadpoles measured (in mm.) 6.6 in total length, 2.3 in body length, and 1.5 in width. Their external gills remained approximately 20 hours after emergence. There were apparently two branches arising near the same spot; the anterior branch was the larger, measuring about 1 mm. in length.

The newly hatched young rested much on their sides or even on their backs on the bottom of the aquaria and every few minutes indulged in violent squirmings which brought them toward the water surface. Twenty-four hours after hatching, the tadpoles measured 8.1 mm. in total length, and more pigmentation was noted. On the second day the young were observed to feed apparently on algae and diatoms, and their measurements were as follows (in mm.): total length, 9.3; body length, 3.3; body width, 2.

On the third day measurements of 11 mm. in total length were recorded and in general the growth appeared rapid. The intestinal coil was now clearly visible through the transparent abdominal wall. The animal food provided was not accepted before the eighth day at which time the tadpoles began to feed upon the termites offered. Later on, as they developed, the tadpoles readily fed upon other insects and crushed snails.

On July 9 the front legs of one of the tadpoles emerged. The total length of this specimen was 32 mm. or 6 to 8 mm. less than the same measurement for field specimens taken at this stage. The tail decreased rapidly from this date and was gone by July 11, making the tadpole stage about thirty days. These transforming young averaged 16.1

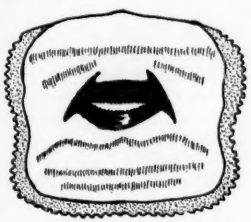
[1] Taylor, *Univ. of Kan. Sci. Bull.*, 20 (11), 1932.
[2] Schmidt, *Scientific Survey of Porto Rico and the Virgin Islands*, New York Acad. of Sci., 10, Pt. I, 1928: 38, 39.
[3] Gaige, unpublished letters, 1935.

mm. from snout to vent; rear leg 25.1 mm; hind foot 12.6 mm.; rear leg adflexed brings heel to rear edge of eye; heel to tip of first toe 6.6 mm.; snout to angle of mouth 4.8 mm.; tympanum 2½ times into eye.

Since numerous transforming young were also found on June 7, and since the first previous heavy rain for many months was about May 2, the tadpole period for the field specimens was judged to be about 30 to 35 days, about the same as for the aquarium raised specimens. These young were hopping about in the grass at the edge of the roadside ditch and were difficult to catch because of their agility. Though adults seemed quite common, they were more difficult to take. Males, when calling from their cavities beneath hummocks of grass, left upon discovery and quickly sought shelter elsewhere. It is believed that the males constructed these cavities to be used by the females for the deposition of the eggs.

The call of the male was repeated at about one second intervals at the height of rapidity, and resembled the plunk-plunk of a drop of water falling from a cave roof into a quiet pool below.

DIAGNOSIS OF TADPOLE.—The tadpoles of *L. labialis* approximate in size those of *L. albilabris*. However, the snout is more elongate; the eyes are farther apart in relation to nostril interspace; the spiraculum nearer middle of the body; the interspace between the two divisions of the second row of labial teeth considerably broader and the two row divisions shorter; and the fifth row of teeth is shorter in relation to the fourth than in *albilabris*.



Mouth of tadpole.

DESCRIPTION OF THE TADPOLE.—Body slightly more than half length of tail; nostrils nearer eye than snout or equidistant. Distance between eyes one-third to one-half more than distance between nostrils and greater than width of mouth. Spiraculum on left side directed backward and upward, and situated above a line between mouth and base of the tail, and but little behind midway point between snout and insertion of rear legs. The lateral edges of horny upper beak drop abruptly. The second row of labial teeth is shorter between extremities than first row and the two halves are separated by an interspace about equal to either lateral half. The fifth row is about one-third shorter than third row and about one-fifth shorter than fourth row. The tail is about three and a half times as long as deep, ending in an obtuse point, both crests confined to the tail, their edges parallel except for posterior third.—STANLEY MULAIK, *Edinburg, Texas.*

NOTE ON A PHILIPPINE COBRA.—In the stomach of a specimen of cobra, identified by the writer as *Naja samarensis* Peters, received from Mindanao, and in the writer's collection, were found two specimens of mammals, evidently murine rodents. One was an adult, with the head and neck digested, the original length of which had probably been about 150 mm. The other was a foetus 41 mm. in length. The mammal material was sent to Prof. E. H. Taylor, who kindly informed me that neither the genus nor species could be determined. According to Taylor (Snakes of the Philippines, Manila, 1922), this cobra is known to feed only on reptiles and amphibians. The exact data are uncertain, but the specimen was not believed to have been kept in captivity. It was collected by I. L. Philips at Maluko, in Bukidnon, western Mindanao, Philippine Islands, in September, 1932.

The snake is further interesting as differing somewhat in coloration from published descriptions of *Naja samarensis*, which is the only cobra known from Mindanao. The snake is shiny black above, brownish black on the head, with the white skin showing between the body scales. The first eleven ventrals are cream color, ventrals 12 to 28 are entirely black, 29 to 36 are partly black along their posterior margins, and 37 to 169 are black only in their postero-lateral corners. A few of those from 37 to 77 have some small black spots on their posterior margins. The length of the cobra as preserved is 1200 mm.; the ventrals number 179, the subcaudals 46, and the scale-rows are 19 to 21 on the neck, 17 at mid-body and 13 anterior to the vent.—J. LINSLEY GRESSITT, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

HYPSIGLENA OCHRORHYNCHUS IN KANSAS AND ADDITIONAL NOTES ON *LEPTOTYPHLOPS DULCIS*.—June 12, 1936, while collecting vertebrate fossils along Bluff Creek in Clark County, Kansas, about two miles up stream from the dam site of the state lake, two specimens of *Hypsiglena ochrorhynchus* Cope were taken. Since this extends the known range of the genus *Hypsiglena* from southern New Mexico northeastward into Kansas, where the form has been heretofore unknown, it seems to warrant the placing of the find on record.

The specimens were found at an elevation of 2350 feet on a small rocky slope facing southeast under flat stones nearly covered by surface wash. June 14, Joe Tihen, of our party, secured an immature specimen below the state lake near the top of the canyon under a pile of small stones. The female taken June 12, was skeletonized and was found to contain 4 eggs. Scale counts were made on the other specimens which are as follows: K.U. No. 20208, ♂; ventrals 168; caudals 54; scale row formula 21-21-17. K.U. No. 20209, im.; ventrals 160; caudals 53; scale row formula 21-21-17.

A specimen each of *Diadophis punctatus arnyi* and *Leptotyphlops dulcis* (Baird and Girard) (K.U. No. 20206), were taken June 12, in association with the two specimens of *H. ochrorhynchus*. This is the second locality record for this rare burrowing snake in Kansas. Another specimen of *L. dulcis* (K.U. No. 20207), was collected June 18, in Meade County, by Mr. Kline, C.C.C. Camp Foreman, at the Meade County State Lake, while quarrying stone. Specimen No. 20206 measured 124 mm. to anus; tail 8 mm.; scale row formula 14–14–14.—CLAUDE W. HIBBARD, *Museum of Vertebrate Paleontology, University of Kansas, Lawrence, Kansas.*

A NEW LOCALITY RECORD FOR *GYRINOPHILUS PORPHYRITICUS* (GREEN) IN MASSACHUSETTS.—Of the sixteen locality records cited by Dunn[1] for *Gyrinophilus porphyriticus* (Green) in Massachusetts, only three are east of the Connecticut River, the remainder being in the extreme western part of the state. Two of the three records for the eastern and central parts of the state are also quite old, going back to the middle of the last century.

During the spring of 1935 students on a collecting trip brought in for identification a specimen that proved to be *G. porphyriticus*. This animal was captured in Amethyst Brook, Pelham, Hampshire County, Massachusetts, which is 12 miles east of the Connecticut River in the Pelham Hills.

The method of capturing this specimen was amusing and resulted from the curiosity of the students regarding the behavior of garter snakes in water. A snake was secured and placed in a pool that bordered a ledge, under which the snake immediately swam, and from which the salamander immediately emerged. The salamander was captured but the snake was lost, much to the chagrin of the collectors.

The specimen measured 118 mm. from snout to the end of the tail, but the tail had been previously damaged, the posterior portion was missing, and that region had healed. The color was pronouncedly salmon with darker mottling, which conformed quite closely to the descriptions. While in an aquarium in the laboratory a small dusky salamander (*Desmognathus fuscus*) was disgorged in a partially digested but recognizable condition.

With the possible exception of the two earliest records from Massachusetts cited by Dunn, Danvers (Holbrook, 1842), and Springfield (Allen, 1868), the other specimens are from the highlands of the state. All those from the western part of the state are from the Berkshire Hills, and the remaining record, Princeton, is in the eastern highlands. This record from Pelham likewise conforms with this distributional trend.—H. E. WARFEL, *Massachusetts State College, Amherst, Massachusetts.*

[1] Dunn, E. R., 1926. The Salamanders of the Family Plethodontidae, Northampton.

REVIEWS AND COMMENTS

OUR NATURAL RESOURCES AND THEIR CONSERVATION. A. E. Parkins and J. R. Whitaker, Editors. John Wiley & Sons, New York, 1936: i–xii, 1–650, many figs. $5.00. The geographers of the land-use school who edited this needed and valuable work, the most thorough as well as most ambitious treatment of the subject since the publication of the classic by Van Hise, and who have contributed the introductory and concluding sections, as well as many of the factual chapters, have done a commendable job of synthesizing the vast and varied field that has been so unfittingly named conservation. The 22 contributors (including both editors) have presented a broad though admittedly not altogether integrated and consistent treatment of the subject.

The wildlife resources seem to have been unduly avoided throughout the book, perhaps because the contributors as a whole felt that these resources were being adequately treated in Prof. V. E. Shelford's *Conservation of Wildlife* (Chapter XIX, pp. 485–526, figs. 1–7). The introductory Part I, *The Conservation Movement in America,* by Wallace W. Atwood, devotes 8 lines to wildlife, despite the large emphasis now being given to wildlife conservation and cropping; and of these 8 lines nearly half refer to a very dubious claim that the killing of alligators in Florida resulted in an increased supply of fish.

In Part II, dealing with the Public Domain and the conservational problems related most directly with the soil, the wildlife resources are accorded little more space. *The Soils of the United States,* as described by Louis A. Wolfanger, almost solely concern agriculture and do not even include the bottom soils of our lakes and streams, although these are of vital concern in the production of aquatic wildlife crops, which are enormously affected, both favorably and adversely, by the materials washed or dissolved out of the land soils. A foreward-looking treatise should have dealt with these relations, in view of the enormous impoundments of water now being constructed and contemplated and in view of the fact, nowhere even mentioned in any of the chapters so far as I can find, that acre for acre water is often more productive of human food and recreation than is land. Neither the amount nor value of the present and especially the potential crop of aquatic wildlife is given any real mention in the chapters on the land areas and soils.

In his chapter *Reclamation of Wet and Overflow Lands,* Prof. George J. Miller goes farther than his colleagues in allowing 6 lines to the mere suggestion that the value of aquatic wildlife should be considered in planning further drainage.

The two chapters on forests by J. R. Whitaker include 3 short paragraphs on recreation (chiefly) and wildlife, though the Forest Service has gone so far into wildlife management as to incur much fear on the part of rival state and federal agencies that their spheres were being unduly entered. Prof. Whitaker, we know, is no mere saw-log forester, but he avoids such pressing problems as whether and how silviculture should be specifically modified to encourage wildlife crops, and whether the total annual value of the game crop over the slow period of growth of saw logs may not in places even exceed the expected value of the timber crop. It is noted that Prof. Whitaker referred to the chapter on wildlife, but as editor he must have known that these vital questions were not adequately discussed in that chapter, nor elsewhere in the book.

Were it not without adequate precedent, we would be greatly surprised and chagrined that the 4 chapters of Part IV, on water resources, do not even mention the enormous effects of water power, waterway and flood control developments on fishes and other economically important aquatic animals. Surely it should have been pointed out how each of these other uses of water have disastrously affected the aquatic wildlife resources—and how each under wise management may in the future lead rather to an increased crop of water wildlife. As usual, flood control is treated as a problem of getting the excess waters with their load of enormously rich organic content directly into the sea. The possibilities are not even suggested, in this ostensibly thorough book on conservation, of spreading the water over lowlands and in canals and ponds, so as to retain and reuse the suspended and dissolved materials washed from the land.

The chapter on wildlife, already referred to, should have treated these vital wildlife problems that are neglected in the other chapters, but to an unhappy degree it fails to do so. It is the product of an arch-leader of the school of ultrapreservationists, therefore of one definitely antagonistic to the members of management school, of one who still thinks of conservation as the problem of maintaining the vanishing remnants of our wildlife, as though they were non-replaceable, of one who fatalistically hardly hopes for the restoration of wildlife resources and has not envisioned the possible increase of much of our wildlife, through environment control and other forms of wildlife management, to an excess of primeval abundance. The preservation of rare animal species, especially those threatened with extinction, is treated very emphatically but not more forcibly than the urgent question warrants; but some may query cerain aspects of the buffer-zone proposal that the author is riding. The destruction of large predators in the National Parks, and the failure of the Park Service to preserve aquatic as well as terrestrial environments and animals, are subjected to valid attacks, even though made in the spirit of a crusader. In this spirit all destruction of ecological associations is bitterly decried, largely because opportunities for ecological research are thereby lost. The need for crusaders may not have passed, but a growing band of wildlife technicians is now leading a movement, which though looked upon with extreme and personal suspicion in the book under review, really promises to replace conservation preaching with effective wildlife research and management. Although this is the movement that is transforming our ideas of "conservation" into one of wildlife cropping, it is scarcely mentioned by Dr. Shelford except as it relates to *preservation* (italics his), to lack of knowledge and to consequent abuses in wildlife management. The whole field of modern fish management seems to have been forgotten; not even a passing mention or footnote is given to lake or stream improvement, for instance, despite the large amount of recent discussion and activity along these lines. The 2 pages on "Wildlife of Waters and Swamps" and the 6 pages on "Aquatic Game Restoration," plus other incidental references to aquatic life, refer more than half to aquatic birds and mammals, leaving less than 5 pages, out of the 650 in the book, to a discussion of the depletion and restoration of fish life. The only definite suggestions made are for the provision of passable fishways and for the abatement of stream pollution (which subjects, considering the excessively limited space, are well treated).

In many other respects *Our Natural Resources and their Conservation* is so much more modern and thorough as to warrant its reading and study by all who are interested in this most fundamental problem. The chapters on *Recreational Resources* by Edward C. Prophet and on *The Conservation of Man* by Ellsworth Huntington, are particularly authoritative and conclusive of thought.—Carl L. Hubbs, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

SNAKES AND THEIR WAYS. By C. H. Curran and Carl Kauffeld. Harper and Brothers, New York and London, 1937: xvii 285; 62 figs. text figs. $3.75.—Layman, amateur, and specialist alike will welcome this attractive volume devoted exclusively to snakes. Based, as the authors tell us, on inquiries received by the American Museum of Natural History, the layman will find it a non-technical, general account of the various species of snakes and their habits, the amateur a fund of basic information, and the specialist a good reference to recommend to those who come to him with their numerous questions.

The volume opens with general considerations of anatomy, classification, and facts about snake venoms and snake-bite treatment which contain the most technical matter in the entire book. The following chapters are devoted to a consideration of the geography, habits, and general information of the various types of snakes. The grouping of these types may prove confusing to the amateur as it treats them both systematically (as rattlesnakes, cobras, etc.) and according to habits (tree snakes, fresh water snakes, etc.) These chapters are followed by several interesting and amusing sections devoted to "snake stories" and a discussion of the roles played by snakes in history and religion, while the final chapter presents a check list of the snakes of the United States. As a whole the material embodied in the volume is well-chosen, interestingly presented, pleasingly written. Keeping in mind the aim of the authors, it is doubtful whether the text material could be improved upon in a volume of the same size.

In criticism, the plates, assembled in the center of the book, warrant first attention. The majority of these will prove familiar to the specialist as few new cuts have been

made. The figures, although following the text in organization, have no text references. Furthermore, despite the fact that the book is obviously designed for the American public, only about one third of the figures depict American species. The remainder are predominately African, while Asiatic, European, and Australian forms are conspicuously absent. Nor are the plates numerically well-balanced. For while ten are devoted to African vipers, none portray such interesting forms as coral snakes and sea snakes.

Few errors in information are to be found, but one in particular deserves notice; bats are referred to as flying rodents (p. 20). Misinformation through inference is likely to lead astray the amateur and layman, as an evident Lamarkian explanation is adhered to throughout the volume. Typographical mistakes are few, the most noticeable occurring in the check list which also has several errors in defining ranges. The authors are to be commended for their attempt to include common names in the check list, but, unfortunately, many of these are poorly chosen and some even devoid of apparent reason (i.e. *Potamophis striatulus* (Linnaeus)=Garman's Brown Snake). An excellent index renders the book extremely useful, but a well chosen bibliography of similar semi-technical or popular volumes might have enhanced its value. Despite these minor criticisms, the clear, concise style of the authors has produced a book which is recommended to all who have even a passing interest in herpetology.—L. C. STUART, *Museum of Zoology, Ann Arbor, Michigan.*

THE FISHES OF JAPAN (in Japanese). By Shigeho Tanaka. Dainippon Tosho Kabushikikaisha, Tokio, Dec. 3, 1936: 1–2, 1–6, 1–234, 1–10,, 40 figs., 18 cm., 1.00 yen ($0.30).—This useful book deals with over 500 species of fresh-water and marine fishes that are found in Japanese waters. It is written in a semi-popular style which, however, does not detract from its ichthyological importance. The main part of the book, comprising 85 chapters, is devoted to a discussion of the more common Japanese fishes, and contains many interesting and valuable suggestions on possible future lines of study of the fishes of Japan. It therefore is of considerable importance to ichthyologists, and particularly to those of Nippon. The book contains the first published figure of the unique trachinoid-like fish, *Henicichthys foraminosus* Tanaka.—KATSUZO KURONUMA, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

TIERGEOGRAPHIE DES MEERES. By Sven Ekman. Akademische Verlagsgesellschaft M. B. H., Leipzig, 1935; i–xii, 1–542, figs. 1–244. 32 R. M.—Monumental, masterful, magnificent, are attributives that come to mind on studying this pioneer encyclopedic treatment of marine zoogeography. Sven Ekman has given to the world a very comprehensive review of an immense field, hitherto represented by hundreds of isolated papers which few others could have so thoroughly coordinated. His treatment is largely regional, almost exclusively so if we regard the benthic, pelagic and bathypelagic realms as regions. The fine chapter on "Meridiane Verbreitung und Bipolarität" is hardly an exception, for it too has a regional basis. Although by no means neglected, generalizations by subject are greatly obscured by the consistently regional treatment, and are thereby scattered, and all but lost in a maze of detail. Thus the phenomenon of isothermal distribution is considered in the chapters on the northern faunas and on bipolarity, but nowhere is there given a unified discussion of the role of temperature in the distribution of animals; nor can one locate the disjoined considerations of this subject through separate headings in the text, in the analytical contents or in the index. The bearing of zoogeography on the problems of speciation is touched upon here and there and summarized in one page at the close of the book, but is not adequately discussed. We look in vain for a definite treatment of geographical isolation as a factor in the speciation of marine animals, for a unified discussion of the factors limiting the distribution of local forms; for a general analysis of the relationships between the characters of marine animals and the physicochemical features of their habitats. We would certainly have expected a chapter treating the outstanding theories that have been proposed to explain the distribution of life on the earth and that apply to littoral in addition to terrestrial and fluviatile animals; we would have welcomed Scandinavian judgment on the great alternative theories of northern dispersal, land-bridges and continental drift. While indicating our

outstanding criticism of this book as an undue subordination of topics to regions, we recognize that the author has followed almost universal precedent, and rejoice that he has broken away from the precedent of drawing "lines" to separate rigidly defined realms, provinces and subprovinces (he does not even mention Wallace's Line by name and only briefly and guardedly describes it). The author seems to have overlooked some interesting zoogeographic phenomena that have been determined by students of the distribution of marine fishes, for example: the absence of macrouroids in the Sea of Japan; the close vertical approximation there of northern and southern faunal elements; high endemism in the depths of the Sulu Sea, associated with isolation in water having a peculiar relation between depth and temperature; the occurrence of a number of Indopacific types on the islands but not the mainland of Pacific America; the penetration of marine types into tropical rivers and fresh-water lakes, especially those with a high calcium content. But the marvel of the book is not the fact that such phenomena have been overlooked (if indeed these points are not somewhere mentioned), but rather that such an enormous amount of material has been included, and so well treated. And considering the enormous quantity and breadth of literature which has been covered and cited, we can surely not complain with good grace that the author, a European invertebrate zoologist, has apparently not consulted certain pertinent fish papers, especially by American ichthyologists. The author deserves our fullest praise; we give it to him.—Carl L. Hubbs, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

THE COMPARATIVE ANATOMY OF THE NERVOUS SYSTEM OF VERTEBRATES, INCLUDING MAN. By C. U. Ariëns Kappers, G. Carl Huber and Elizabeth Caroline Crosby. Macmillan Co., New York, 1936, 2 vols: i–xxvi, 1–1845, figs. 1–710. $16.00.—Some outstanding recognition should be devised for great scientists who unselfishly devote long years and unmeasured energy to the production of encyclopedic summaries of their science. These treatises help to avoid the loss or duplication of research work, hold the framework of the science together and provide the foundation for the effective and orderly growth of the science. The two-volume work under review is hailed as a splendid example of such monographs. In it there is presented the available information on the anatomy of the central nervous system in vertebrates, from lancelet to man. Chapter by chapter, each part of the nervous system is considered according to advancing zoological order. An adequate topical index complements this phyletic treatment. Each important statement is documented by one or more references to the nearly 300 pages of bibliography. One marvels at the effectiveness of three nervous systems capable of preparing a work so vast, complete and useable.—Carl L. Hubbs, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

Recent Fish and Reptile Books

Physiologie der Süsswasserfische Mitteleuropas. By Wilhelm Wunder. Handbuch der Binnenfischerei Mitteleuropas, Vol. II B, 1936: i–xi, 1–340, figs. 1–213, pls. 1–10.

The Complete Aquarium Book The Care and Breeding of Goldfish and Tropical Fishes. By William T. Innes. Halcyon House, New York, 1936: 1–317, figs. 1–300, 10 col. pls. $1.89.—A popular (16th) edition of Innes' *Goldfish Varieties and Tropical Aquarium Fishes,* with the addition of colored plates from the author's *Exotic Aquarium Fishes* and his magazine *The Aquarium.*

Report of the Reelfoot Lake Biological Station, Tennessee Academy of Science, Nashville, Vol. 1, 1937: 1–162, many figs.—In addition to brief reports on the operation of this station, and papers on the ecology of Reelfoot Lake, this volume contains articles by C. L. Baker on The Commercial, Game, and Rough Fishes of Reelfoot Lake (pp. 9–54, figs. 1–27, 3 col. pls.) and on Game Laws and Fishing in Reelfoot Lake (pp. 55–59); a paper by Malcolm V. Parker on Some Amphibians and Reptiles from Reelfoot Lake (pp. 60–86, figs. 1–18), and one by Fred R. Cagle on Egg Laying Habits of the Slider Turtle (Pseudemys troostii), the Painted Turtle (Chrysemys picta), and the Musk Turtle (Sternotherus odoratus) (pp. 87–95, fig. 1).

Snakes of Maryland. By Howard A. Kelly, Audrey W. Davis and H. C. Robertson. The Natural History Society of Maryland, Baltimore, 1936: 1–103, with 15 colored plates reproduced from R. F. Deckert's paintings and 33 half-tones.

EDITORIAL NOTES AND NEWS

Meetings of the Society

THE 1937 meeting of the American Society of Ichthyologists and Herpetologists will be held at Washington on May 5–8. Sessions for the reading of papers will be held at the National Museum on the first two days (Wednesday and Thursday). On Friday (May 7) a field trip is planned to a cypress swamp about 60 miles from Washington, and on Saturday a trip will be made to the National Zoo. Headquarters will be at the Harrington Hotel, where the annual dinner is scheduled for the evening of May 5. Titles or inquiries may be sent to the Secretary, or to the local chairman (DR. LEONARD P. SCHULTZ, U. S. National Museum). It is hoped that the meeting will be well attended.

Western Division

THE Western Division of the Society will meet with the American Association for the Advancement of Science in Denver, June 21–26. Special notice of the day and place of the Division meeting, and information regarding accommodations in Denver, will be sent to all western members by the Secretary of the Western Division, Dr. GEORGE S. MYERS, Stanford University, California. Eastern members expecting to attend should communicate with the Secretary immediately. Since this is to be a general, rather than a Pacific Division meeting of the American Association, an especially interesting program and large attendance is certain.

Catalogue of the Fishes of the British Museum

THE Trustees of the British Museum (Natural History) are photographically reprinting *The Catalogue of the Fishes of the British Museum*, by Albert Günther, originally published from 1859 to 1870. This, the last of the world-wide monographs of fishes, and probably the most valuable ichthyological treatise ever published, has long been out of print. So great has been the demand for this almost indispensable work, that the price for second-hand copies of the 8 volumes has risen to above $200. It is therefore a real source of gratification that the price for the facsimile edition has been set at the original price of publication: Vol. I, 10c; II. 8s–6d; III, 10s–6d; IV, 8s–6d; V, 8s; VI, 7s; VII, 8s; VIII, 8s–6d; price for the complete work £3–9s–0d. Orders should be sent to Wheldon and Wesley, Ltd., 2–4 Arthur Street, New Oxford Street, London, W.C.2., England.

Herpetological News Notes

ON April 1, CURATOR KARL P. SCHMIDT and L. L. WALTERS, of the Field Museum of Natural History, left for Arizona, to collect material for desert groups for their institution in the area about Yuma. DIRECTOR HOWARD K. GLOYD, of the Chicago Academy of Sciences, leaves for Arizona in April, accompanied by MRS. GLOYD and a number of his staff members, to collect higher vertebrates and insects in the mountains north of Phoenix. CURATOR JOSEPH R. SLEVIN, of the California Academy of Sciences, will return shortly from his herpetological collecting trip to Australia.

Recent appointments include those of DR. C. H. KAUFFELD to the position of Curator of Reptiles in the Staten Island zoo, and of DR. C. M. BOGERT as Assistant Curator in the Department of Herpetology, American Museum of Natural History. DR. GORDON WALLS has resigned from the staff of the University of Iowa, and is now associated with the Biological Supply Co. of Chicago.

RALPH DE SOLA is a member of a group of writers who are preparing a zoological trilogy "Who's Who at the Zoo." Part I, on mammals is nearly completed, Part II, on birds, reptiles and amphibians is in process of preparation, and Part III will include fishes and evolution. They are to be profusely illustrated with maps and half tones and will include a readable and scientific narrative treatment of all of the vertebrate orders.

MR. C. M. KNOLL, 415 Washington Ave., Grantwood, New Jersey, has requested that museums and private collectors send him data for their collections of *Terrapene*, including if possible species, state, county, date, locality, and number of specimens taken.

Fish Research News Items

THE SECOND NORTH AMERICAN WILDLIFE CONFERENCE, held at St. Louis on March 1–4, featured 3 half-day technical sessions devoted chiefly to fish and fishery problems: a symposium on the management of impounded waters; a symposium on pollution and silting of streams and lakes, and a general session on fish management. The American Wildlife Institute and its Technical Committee also held meetings at St. Louis. DR. MAX M. ELLIS of the University of Missouri and the U. S. Bureau of Fisheries was elected to the Institute's Technical Committee.

At St. Louis, the Society of Wildlife Specialists, provisionally organized at Washington last year, was formally organized and renamed THE WILDLIFE SOCIETY. The Society includes workers in fish as well as game management, and proposes to launch in 1937 the Journal of Wildlife Management, probably as a quarterly, under the editorship of DR. W. L. MCATEE of the U. S. Biological Survey. Major objectives are the development of all types of wildlife management along sound biological lines, the establishment of professional solidarity among conservation biologists and the maintenance of the highest possible professional standards. The officers for 1937 include PRESIDENT RUDOLPH BENNITT and SECRETARY VICTOR H. CAHALANE of the National Park Service, Washington, D. C. Active and associate memberships are provided.

The first COOPERATIVE FISH MANAGEMENT UNIT has been established at the University of Michigan. It is sponsored jointly by the American Wildlife Institute, the Michigan Department of Conservation and the University. The first project is an investigation of the problems of fish predators—their food, their effects on the fish populations and fish yield, and feasible means for their control, when needed and if possible by other means than killing. This project is now being conducted under KARL F. LAGLER.

DR. CHARLES J. FISH of Rhode Island State College announces that this school is now developing a curriculum for training students in fishery biology and is undertaking marine fishery investigations. A marine laboratory, under construction on Narragansett Bay, will serve as headquarters for such investigations.

PROF. JOHN O. SNYDER retired on January 1 as head of the Bureau of Fish Culture of the California Fish and Game administration. His former assistant Alan Taft has been placed in charge of the Bureau. *California Fish and Game,* now the scientific organ of the Division of Fish and Game, is being edited by Richard Croker of the Calfornia State Fisheries Laboratory.

The Fisheries Service Bulletin announces that "DR. SAMUEL F. HILDEBRAND, senior ichthyologist of the Bureau of Fisheries left Washington on January 15 for the Canal Zone on a two months' detail to continue the investigation he began on a similar trip in 1935. The work is being carried on cooperatively by the U. S. Bureau of Fisheries, the Gorgas Memorial Laboratory in Panama City, and the Panama Canal Government."

Recent Deaths

DR. MAX WEBER, famed zoologist, died at Eerbeek in February, at the age of 84. Although a worker also in other fields, Dr. Weber became one of the world's leading ichthyologists, on account of his many contributions to the knowledge of East Indian fishes. His masterpieces are The Fishes of the Siboga Expedition, and The Fishes of the Indoaustralian Archipelago, the latter still appearing under the authorship of Weber and de Beaufort.

DR. WILLIAM HARDING LONGLEY, Professor of Biology at Goucher College since 1919, and director of the Marine Laboratory at Tortugas of the Carnegie Institution of Washington, died on March 10 at the age of 56. It is widely known that Dr. Longley did a prodigious amount of work on the habits and systematics of tropical marine fishes, especially those of the Tortugas region; but he published only a few short preliminary papers on this work. His projected systematic revision of the West Indian marine fish fauna is reported to have been nearly finished.

Prof. JESSE EARL HYDE of Western Reserve University and the Cleveland Museum of Natural History, well known for his work on the fossil fishes of the Cleveland shales, died on July 3, 1936. An obituary notice has appeared in *Science* for January 1.

Aid to Copeia

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